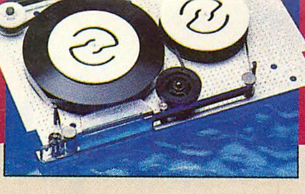
TAPE BACKUP FOR LANs▶

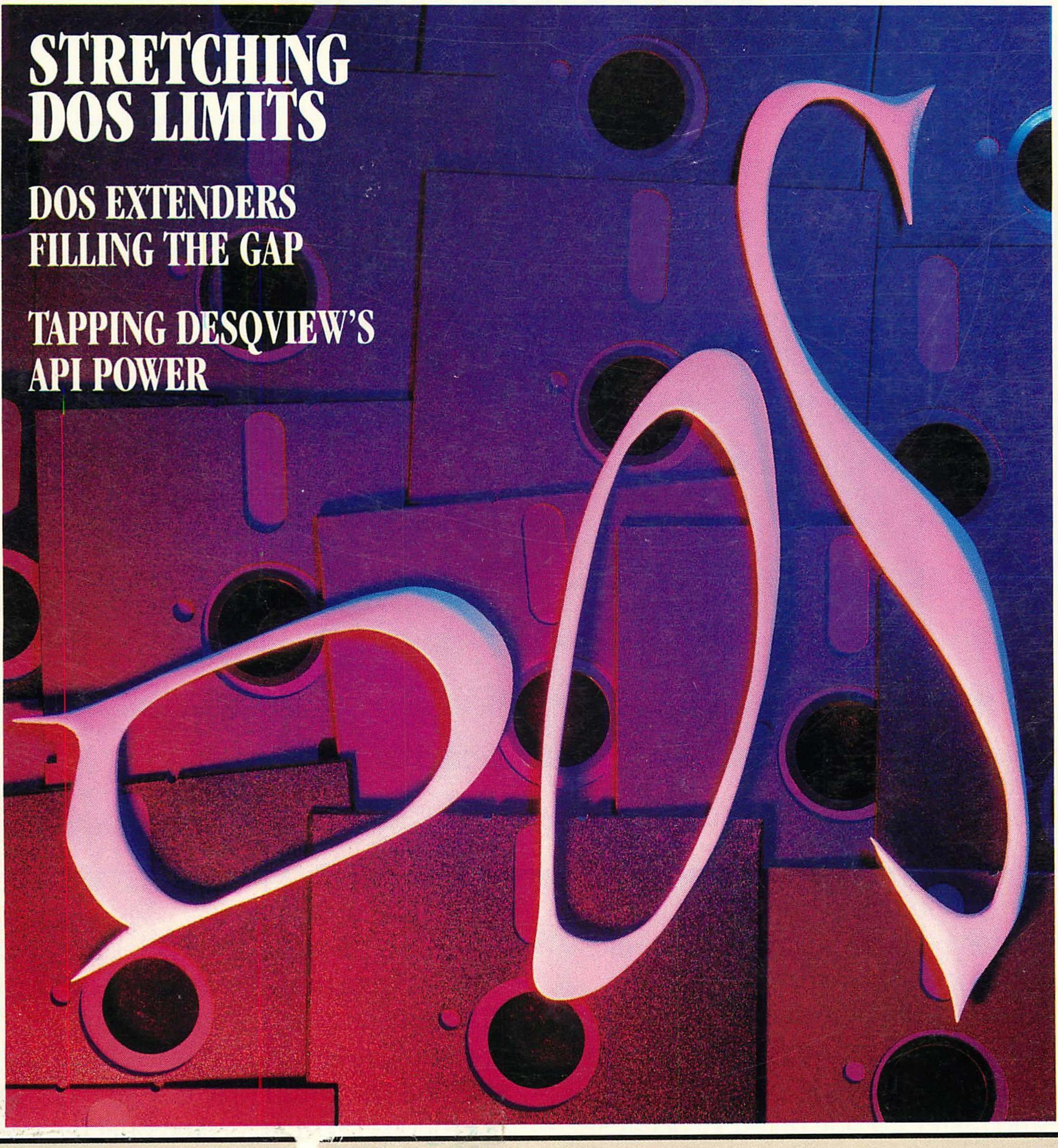


TANDY'S MICRO CHANNEL MACHINE

APRIL 1989 VOL. 7 NO. 4 $3.95

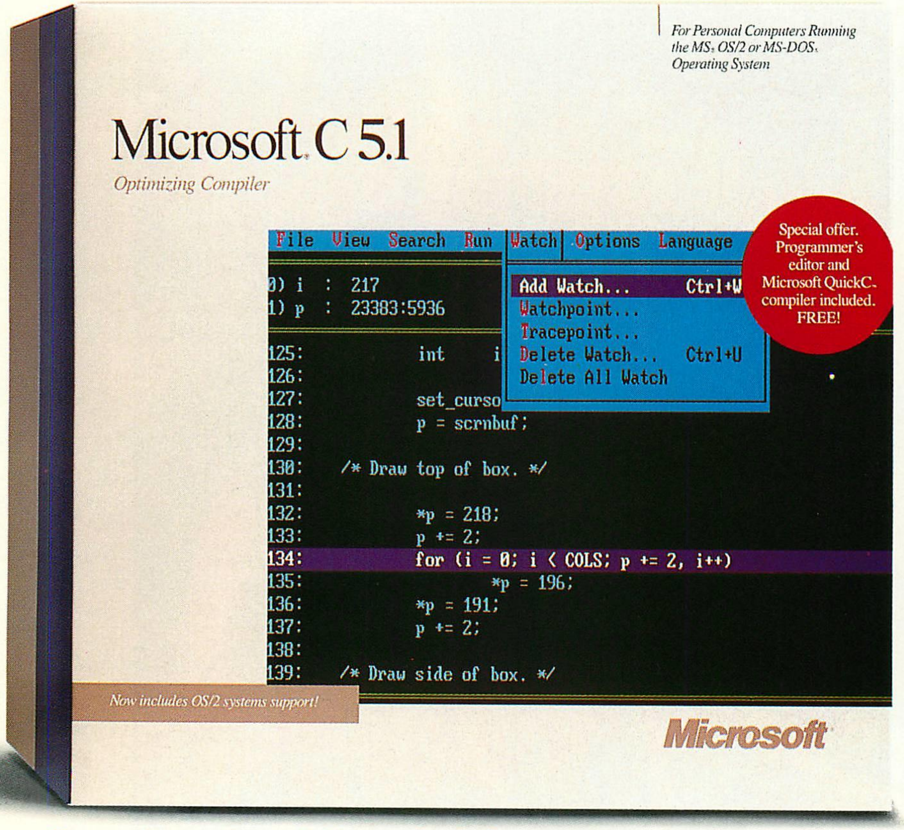
PC TECH JOURNAL®

FOR SYSTEMS DEVELOPERS AND INTEGRATORS



04
0 71486 02166 7

The fastest possible way to create the fastest MS-DOS programs possible.



Microsoft C Optimizing Compiler 5.1 Techbox

Compiler
- Optimizations that generate the fastest code for DOS and OS/2 systems.
  - In-line code generation.
  - Loop optimizations.
  - Elimination of common subexpressions.
- Full OS/2-system support to break the 640K barrier.
  - Family API programs that run under DOS and the OS/2 systems.
  - Write multithreaded programs and Dynamic Link Libraries.
- Small, medium, compact, large, and huge memory models.
- Mix models with NEAR, FAR, and HUGE keywords.
- Fast compilation (10,000 lines/minute) with Microsoft QuickC.™
- Fastest math, in-line 8087/80287 instructions, and floating-point calls.
- More complete support of proposed ANSI standard.
- Over 350 library functions, including a graphics library.

Microsoft CodeView
- Full OS/2 systems support.
  - Debug applications of up to 128 MB under the OS/2 systems.
  - Debug multithreaded programs and Dynamic Link Libraries.
- Source-level debugging for precise control over programs.
  - Dynamic breakpoints in the source.
  - Debug programs written in a variety of Microsoft languages.
  - Full symbolic display of C structures.
  - Interactively follow linked lists and nested structures.
  - Watch variables, memory, registers, and flags.

Other Utilities
- Fast linking (twice as fast as the C 4.0 version linker).
- OS/2 incremental linker – up to 20 times faster than a full link.
- OS/2- and MS-DOS reconfigurable programmer's editor.

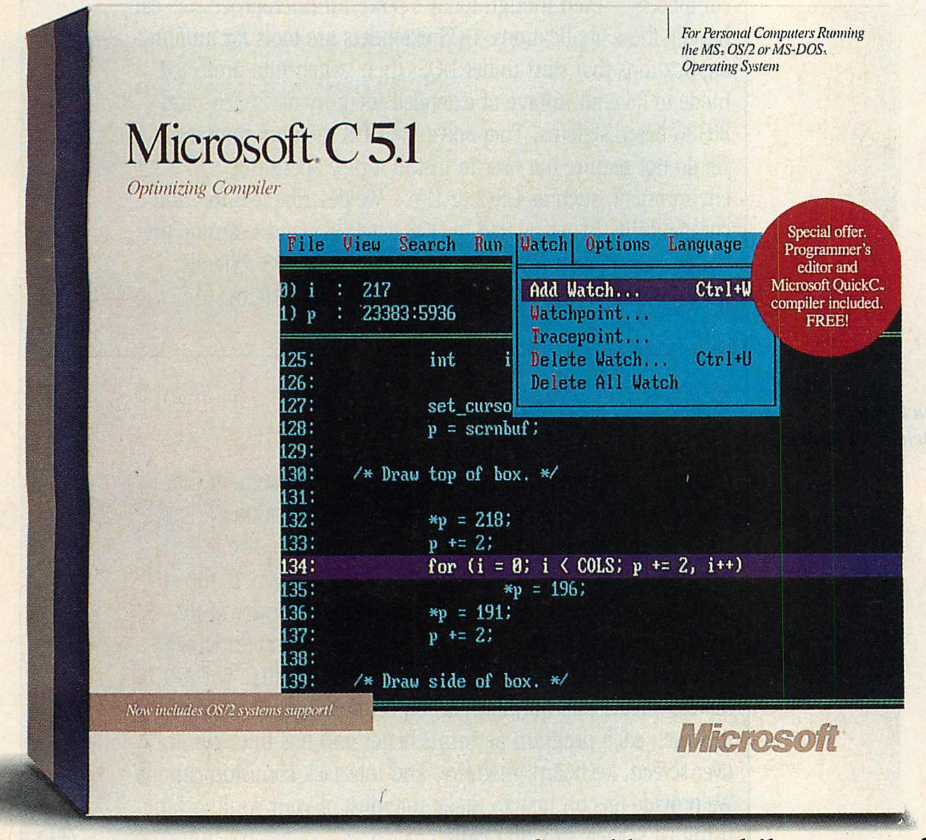
Everything about Microsoft® C Optimizing Compiler version 5.1 is dedicated to the professional programmer.

Fast code. Fast development. Fast debugging. And full support for both MS-DOS® and the OS/2 systems in a single package.

There's no faster C code on a PC, because powerful optimizations, such as in-line code generation and loop enregistering, generate executables that are compact and efficient. The documentation even teaches you special coding techniques to squeeze every last bit of speed out of your code.

Fast code isn't all you get. Under MS® OS/2, the 640K barrier is gone so you can write C programs as large as a gigabyte. You can call the operating system directly. Create more responsive programs (multiple threads allow program operations to overlap). And build Dynamic Link Libraries (DLLs) that can be shared, saving valuable memory. DLLs also allow your main programs to be smaller, so they load faster. You can even write a single Family API program that runs under both MS-DOS and MS OS/2.

The fastest possible way to create the fastest MS OS/2 programs possible.



Microsoft C Optimizing Compiler 5.1 Techbox

Compiler
- Optimizations that generate the fastest code for DOS and OS/2 systems.
  - In-line code generation.
  - Loop optimizations.
  - Elimination of common subexpressions.
- Full OS/2-system support to break the 640K barrier.
  - Family API programs that run under DOS and the OS/2 systems.
  - Write multithreaded programs and Dynamic Link Libraries.
- Small, medium, compact, large, and huge memory models.
- Mix models with NEAR, FAR, and HUGE keywords.
- Fast compilation (10,000 lines/minute) with Microsoft QuickC.™
- Fastest math, in-line 8087/80287 instructions, and floating-point calls.
- More complete support of proposed ANSI standard.
- Over 350 library functions, including a graphics library.

Microsoft CodeView
- Full OS/2 systems support.
  - Debug applications of up to 128 MB under the OS/2 systems.
  - Debug multithreaded programs and Dynamic Link Libraries.
- Source-level debugging for precise control over programs.
  - Dynamic breakpoints in the source.
  - Debug programs written in a variety of Microsoft languages.
  - Full symbolic display of C structures.
  - Interactively follow linked lists and nested structures.
  - Watch variables, memory, registers, and flags.

Other Utilities
- Fast linking (twice as fast as the C 4.0 version linker).
- OS/2 incremental linker – up to 20 times faster than a full link.
- OS/2- and MS-DOS reconfigurable programmer's editor.

Microsoft Editor is the first reconfigurable text editor for programmers that lets you develop under MS-DOS and MS OS/2. Under MS OS/2, multitasking lets you edit one file while you compile another, which cuts development time. You can even generate multiple compiles that report errors directly back into your source code.

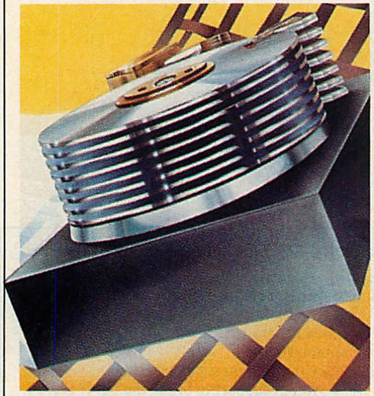
Microsoft CodeView® is the highly acclaimed window-oriented source-level debugger that makes debugging not only fast, but extremely efficient. You can view program execution while you watch variables and register values change. And under MS OS/2 you can debug multi-threaded applications, DLLs, and programs as large as 128 MB. The Microsoft C Optimizing Compiler 5.1, designed for the professional programmer. It's all the speed you need. Call (800) 541-1261.

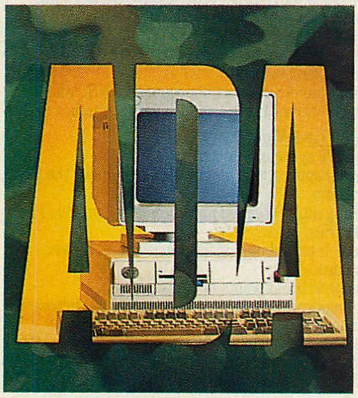
Microsoft®

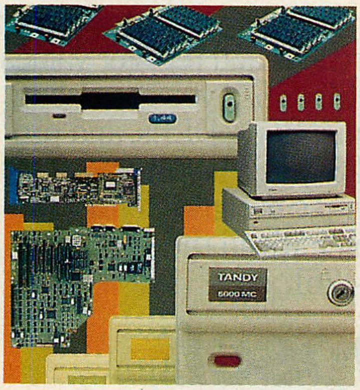
Making it all make sense.™

PC TECH JOURNAL

FOR SYSTEMS DEVELOPERS AND INTEGRATORS







COVER SUITE: STRETCHING DOS

LOCAL AREA NETWORKS

DEPARTMENTS

Cover photography·Studio 65

PC TECH JOURNAL

VOL. 7, NO. 4

PUBLISHER: *Donald J. Byrnes*
EDITORIAL DIRECTOR: *Will Fastie*
EDITOR: *Julie Anderson*

EDITORIAL
EXECUTIVE EDITORS: *Susan Holly, David Methvin*
SENIOR TECHNICAL EDITOR: *Jim Shields*
TECHNICAL EDITORS: *Philip N. Hisley, Ted Mirecki, Chet Schuyler*
SENIOR EDITOR: *Gail Shaffer*
ASSOCIATE EDITORS: *David Robb, Jordene Zeimetz*
SENIOR COPY EDITORS: *Bruce Ansley, Mary S. Moynihan*
COPY EDITOR: *Barbara Hollis*
EDITORIAL PRODUCTION ASSISTANT: *Katherine M. Kiwak*
NEW PRODUCTS EDITOR: *Carole Eyring*
LAB TECHNICIAN: *Todd Bannar*
EDITORIAL ASSISTANT: *Barbara Smith*
BUSINESS MANAGER: *Trish Ledbetter*
EDITORIAL SECRETARY: *Beth Sauberlich*
RECEPTIONIST: *Tobie J. Ketterer*
CONTRIBUTING EDITORS: *Steven Armbrust, Dave Browning, David Claiborne, Peter C. Coffee, Richard M. Foard, Ted Forgeron, Thomas V. Hoffmann, Dennis Linnell, Max Stul Oppenheimer, Kent Quirk*

ART AND PRODUCTION
ART DIRECTOR: *Sharon Reuter*
ASSOCIATE ART DIRECTOR: *Courtney Barone*
ASSISTANT ART DIRECTOR: *Crystal Hopkins*
ART ASSISTANT: *Cheri Glover*
PRODUCTION MANAGER: *Alison Regan Mrohs*
CONTRIBUTING ARTISTS: *Maciek Albrecht, David Povilaitis*

ADVERTISING SALES
NATIONAL ADVERTISING DIRECTOR: *Rita Burke*
NATIONAL TELEMARKETING MANAGER: *Arlene Braithwaite*
ADVERTISING MANAGER/WEST COAST: *Jeff Hoopes*
MARKETING DIRECTOR: *Marti Cunha*
ASSISTANT MANAGER OF MARKETING: *Kimberly Schroeder*
MARKETING COORDINATOR: *Debbie Lintner*
ASSISTANT TO THE PUBLISHER: *Lucy Frazer*
ADVERTISING COORDINATOR: *Mary Barrow*
DISTRICT MANAGERS: *Bill Barney–Southeast and Eastern Canada; Melinda Maginn–New England; John Blake–Mid-Atlantic; Stephen Dress–Midwest; Elaine Ebner, Deborah Kendall, Mark Alden–West Coast*
ACCOUNT REPRESENTATIVES: *Patrick O'Brien–Southeast and New England; Nannette Vilushis–Midwest and Mid-Atlantic; Mary Martin–West Coast; Classified Advertising Director–Kathryn Cumberlander*

CIRCULATION
SUBSCRIPTION DIRECTOR: *Paul Stafford*
SINGLE-COPY SALES DIRECTOR: *Robert Woltersdorf*

GROUP VICE PRESIDENT: *J. Scott Briggs*

ZIFF-DAVIS PUBLISHING COMPANY, *a division of Ziff Communications Co.*
PRESIDENT: *William Lohse*
GROUP VICE PRESIDENTS: *J. Scott Briggs, William Lohse*
SENIOR VICE PRESIDENT, Marketing: *Paul H. Chook*
VICE PRESIDENT, Operations: *Baird Davis*
VICE PRESIDENT, Controller: *John Vlachos*
VICE PRESIDENT, Creative Services: *Herbert Stern*
VICE PRESIDENT, Research: *Marian O. White*
VICE PRESIDENT, Classified Advertising: *Alicia Marie Ivans*
VICE PRESIDENT, Circulation: *Bert Lacy*
VICE PRESIDENT, Circulation Services: *James Ramaley*
VICE PRESIDENT, Marketing Services: *Ann Pollak Adelman*
VICE PRESIDENT, Development: *Seth Alpert*
VICE PRESIDENT, Production: *Roger C. Herrmann*
DIRECTOR OF PLANNING: *Gary A. Gustafson*
PRODUCTION DIRECTOR: *Walter J. Terlecki*

ZIFF COMMUNICATIONS COMPANY
CHAIRMAN: *William B. Ziff, Jr.;* VICE CHAIRMAN: *Philip B. Korsant;* PRESIDENT: *Kenneth H. Koppel;* EXECUTIVE VICE PRESIDENT: *Stephen C. Kahler;* SENIOR VICE PRESIDENTS: *Philip Sine, Hugh Tietjen;* VICE PRESIDENTS: *William L. Phillips, J. Malcolm Morris, Steven C. Feinman;* SECRETARY: *Bertram A. Abrams*

EDITORIAL OFFICE
PC Tech Journal, Suite 800, 10480 Little Patuxent Parkway, Columbia, MD 21044-3506; 301/740-8300. FAX (group 3): 301/740-8809. MCI Mail: PCTECH. PCTECHline: 301/740-8383 (2400/1200/300 bps, 8 data bits, 1 stop bit, no parity). Telex: 6502565932 MCI.

ADVERTISING OFFICES
Corporate/Southeast/Canada: Suite 800, 10480 Little Patuxent Parkway, Columbia, MD 21044-3506; 301/740-8300. *New England:* 144 Watching Avenue, Upper Montclair, NJ 07043; 201/509-8148. *Mid-Atlantic:* 89 Pearsall Place, Merrick, NY 11566; 516/546-7505. *Midwest:* Suite 1400, 180 N. Michigan Avenue, Chicago, IL 60601; 312/346-2600. *West Coast:* 3460 Wilshire Blvd., Los Angeles, CA 90010; 213/387-2100. 110 Marsh Drive, Foster City, CA 94404; 415/378-5580.

SUBSCRIPTION INQUIRIES
PC Tech Journal, P.O. Box 2968, Boulder, CO 80321. Subscription service: 303/447-9330. For back issues (subject to availability) send $7.00 per copy, $8.00 outside U.S. to: Ziff-Davis Publishing Company, P.O. Box 5999, Cherry Hill, NJ 08034, Attn: F. Hunter; 609/354-4975.

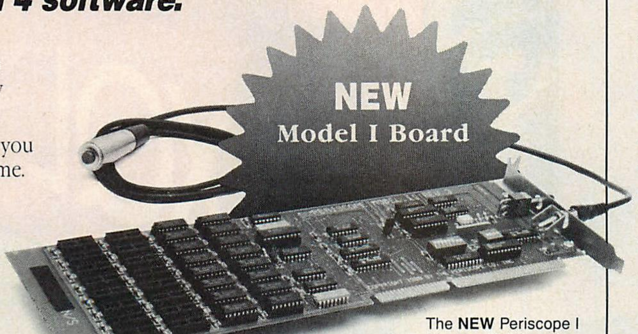
PC Tech Journal (ISSN 0738-0194) is published monthly by Ziff-Davis Publishing Company, a division of Ziff Communications Company, One Park Avenue, New York, NY 10016. Subscription rate is $34.97 for one year (12 issues). Additional postage for Canada and Foreign is $10.00 per year. Second-class postage paid at New York, NY, and at additional mailing offices. POSTMASTER: Send address changes to *PC Tech Journal*, P.O. Box 55761, Boulder, CO 80321.

You No Longer Have to Share the Lower 640K With Your Debugger

Periscope I's new board uses ZERO memory in the lower 640K. Yet it has plenty of room to safely store all debugging information, like symbols, as well as the powerful Version 4 software.

Periscope's hardware adds the power to solve the really tough debugging problems.

The break-out switch lets you break into the system any time. You can track down a bug instantly, or just check what's going on, without having to reboot or power down and back up. That's really useful when your system hangs! The switch is included with Periscope I, Periscope II, and Periscope III.

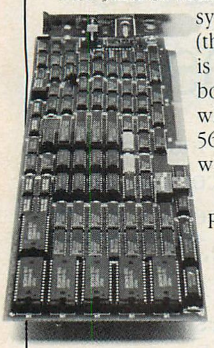


The **NEW** Periscope I memory board keeps all debugging information out of the lower 640K. Can be used in PCs, ATs, and 386s with both EGA/VGA and EMS boards installed. The Periscope break-out switch enables you to recover from a hung system. Included with Models I, II, and III.

Periscope I has a **NEW** board with 512K of write-protected RAM, user-expandable to 1MB, for the Periscope software, symbol tables, and all related debugging information. Normal DOS memory (the lower 640K) is thus totally freed up for your application, and Periscope is protected from being overwritten by a run-away program. The new board's footprint is only 32K, so you can use it in PC, AT, and 386 systems with EGA/VGA and EMS boards installed (not possible with the previous 56K board). It can also be used with Periscope III to provide additional write-protected memory.

Periscope III has a board with 64K of write-protected RAM to store the Periscope software and as much additional information as will fit. AND...

The Periscope III board adds another powerful dimension to your debugging. Its hardware breakpoints and real-time trace buffer let you track down bugs that a software-oriented debugger would take too long to find, or can't find at all!



The Periscope III hardware-breakpoint board captures information in real-time, so you'll find bugs that can't be found with a software-based debugger.

Periscope's software is solid, comprehensive, and flexible.

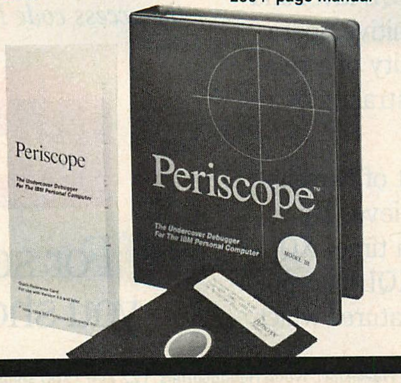
It helps you debug just about any kind of program you can write... thoroughly and efficiently.

Periscope's the answer for debugging device-drivers, memory-resident, non-DOS, and interrupt-driven programs. Periscope works with any language, and provides source and/or symbol support for programs written in high-level languages and assembler.

David Nanian, President of Underware, Inc. (of BRIEF fame) says this about the new Periscope Version 4:

"Periscope has always been an unbelievable assembler-level debugger. Version 4 has turned it into a terrific source-level debugger as well. Aside from major enhancements like the source-level improvements, all the little changes make a really big difference, too. For instance, symbol lookups and disassemblies are noticeably faster, and highlighting the registers that have changed really makes life easier. Once again, Periscope industry standard for debugg

Periscope software & 250+ page manual



What's New in Periscope Version 4:

- View local symbols from Microsoft C (Version 5)
- Debug Microsoft windows applications
- Set breakpoints in PLINK overlays
- Improved source-level support
- Monitor variables in a Watch window
- 80386 debug register support
- Debug using a dumb terminal
- PS/2 watchdog timer support
- Use mixed-case symbols
- Set breakpoints on values of Flags
- Much more!

- **Periscope I** includes a **NEW** full-length board with 512K of write-protected RAM; (user-expandable to 1MB); break-out switch; software and manual for $795.
- **Periscope II** includes break-out switch; software and manual for $175.
- **Periscope II-X** includes software and manual (no hardware) for $145.
- **Periscope III** includes a full-length board with 64K of write-protected RAM, hardware breakpoints and real-time trace buffer; break-out switch; software and manual. Periscope III for machines running up to 10 MHz with one wait-state is $1395. Plus the new Model I board, $1995.

Due to the volatility of RAM costs, prices on board models are subject to change without notice.

REQUIREMENTS: IBM PC, XT, AT, PS/2, 80386 or close compatible (Periscope III requires hardware as well as software compatibility, thus will not work on PS/2 or 80386 systems); DOS 2.0 or later; 64K available memory (128K at installation time); one disk drive; an 80-column monitor.

Call us with your questions. We'll be happy to send you free information or help you decide on the model that best fits your needs.

Order Your Periscope, Toll-Free, Today!

800-722-7006

MAJOR CREDIT CARDS ACCEPTED

The Periscope Company, Inc.

1197 PEACHTREE ST. • PLAZA LEVEL
ATLANTA, GA 30361 • 404/875-8080

CIRCLE NO. 215 ON READER SERVICE CARD

Finally, there's an SQL that gets back to BASIC. And COBOL. And C. And Pascal.

As a programmer, you've probably already faced it—the database dilemma. Do you use an SQL for easy database handling, or a true programming language for maximum power and flexibility?

Now you can do both with XQL,® the relational data management system from the developers of Btrieve.®

The Programmer's SQL. With XQL, you can access your data with the ease of Structured Query Language through simple subroutine calls from traditional programming languages. XQL supports standard SQL syntax, including subqueries, unions and security groups.

XQL Relational Primitive Operations. In addition, XQL lets you bypass the SQL level and perform highly efficient, relational primitive operations directly. You get all the functionality of a relational database model without the constraints of a 4th generation language.

Building on Btrieve. The heart of Novell's family of data management tools is Btrieve. By letting you access multiple records at a time, XQL adds a powerful dimension to Btrieve. XQL incorporates sophisticated data manipulation features which allow you to access data by field name, move forward or backwards through the database, compute fields from other fields or constants, and even work with composite records built from multiple, joined Btrieve files.

Like Btrieve, XQL offers features like multiuser support, fault tolerance, comprehensive documentation, and expert technical support. And you never pay royalties on your XQL applications.

Solve the database dilemma with XQL, the SQL that speaks your language. Only $795.* See your Authorized Novell Gold Reseller, or call us at (512) 346-8380.

For more information, call from your modem 1-800-444-4472 (8 bit, no parity, 1 stop bit) and enter the access code NVXQL3.

NOVELL

For software solutions, you should be seeing red.

*Suggested retail price (US dollars) ©1988 Novell Inc., World Headquarters, 122 East 1700 South, Provo, Utah 84601 (801) 379-5900
Requires Btrieve 4.x and PC-DOS or MS-DOS 2.x, 3.x.

CIRCLE NO. 201 ON READER SERVICE CARD

JULIE ANDERSON

EMS: The M Stands for Memory

Many avoid moving to OS/2 because of the high cost of memory, but confusion between EMS and overlays could be the trouble.

J Anderson

GOODBYE, OLD FRIEND

With this issue, we ask you to join us in saying goodbye to an old friend, PC Tech Journal. *After nearly six years, this is the last issue we will publish. The staff of* PC Tech Journal *wants to thank all of our readers. You supported us from the beginning in our endeavor to produce a top quality, technically sophisticated magazine. It has been rewarding to create a magazine for readers who care so deeply.*

Many people list the high cost of memory as their major reason for not moving from DOS to OS/2. They want to multitask several programs, but they say that OS/2 requires too much memory; they will use expanded memory instead. When I hear people say this, I think they must be confusing expanded memory with overlays. The two memory-addressing schemes are similar, but different.

Overlays are portions of program code that share the same physical memory at different times. The code is stored on disk and loaded as needed. Most major DOS applications are heavily overlaid. If a sophisticated application claims it can run in 256KB, it means that it can survive with 256KB of program code and data in physical memory at one time.

The rest of the program resides on disk and is brought into memory when needed, replacing code that is not currently required. The developer must design the application so it can be subdivided into independent parts. Otherwise, thrashing occurs as a piece of code is loaded, replaced, and then reloaded in short succession. Even with a good overlay design, accessing the disk during program execution slows down the application; so, developers use overlays only when necessary.

OS/2 allows developers to eliminate overlays. In fact, many developers find that their ported applications run faster under OS/2 than under DOS simply because they are able to load the entire program into memory at once. This means, of course, that OS/2 applications often require more memory than their DOS counterparts.

In contrast to overlays, expanded memory (compliant with the EMS 4.0 specification) uses bank-switching to share the same logical memory locations among different physical memory addresses. Like OS/2, the entire program is resident in memory. Instead of swapping data from the disk, the logical window is slid over the appropriate piece of physical memory. As with overlays, the program and its data must be subdivided into independent parts. Although only a small logical window of memory is accessible at one time, all of the memory being bank-switched must be physically present at all times. This means you must populate your system with enough memory to accommodate all of the programs you want to multitask at the same time.

HOW MUCH TO BUY

The amount and type of memory you need is determined by the operating environment and applications that you are running.

Every operating environment has overhead. OS/2 Standard Edition needs about 1.5MB to load. In addition to the memory needed by OS/2, a large application could require from 1 to 1.5MB. For example, the OS/2 version of Oracle Corporation's ORACLE requires 896KB. It's safe to say that an OS/2 system running several large and small applications (at the same time) requires at least 4MB.

Another way to multitask applications is to stretch DOS—the subject of our cover suite—by using Quarterdeck's DESQview with expanded memory. When used with memory that is compatible with EMS 4.0, DESQview loads some of itself into expanded memory and allocates expanded memory for each task so that it can switch contexts by mapping the program's page frames into the DOS address space. (DESQview's API is the subject of "Drawing Out DESQview Power" by Fred Hitt on page 46.) It's easy to eat up 2MB with only a few programs loaded, making system memory requirements under DESQview about 2.5MB. In contrast to OS/2, each program has access to less than 640KB of addressability and may need to stretch itself by using overlay techniques, expanded memory, or a DOS extender.

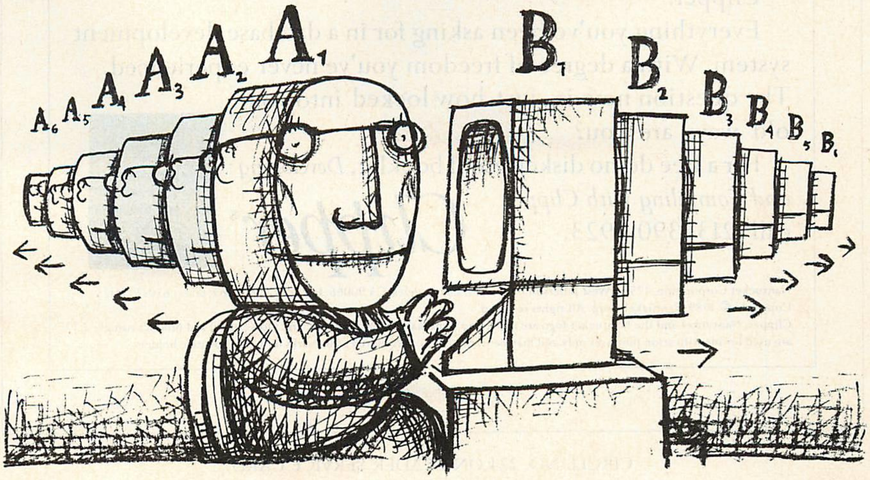


ILLUSTRATION • MACIEK ALBRECHT

For each application that uses expanded memory, an appropriate amount of memory must be added.

DOS extenders add little memory overhead, but they do allow the application to address extended memory using protected mode. (William Brooks examines DOS-extender technology in "Leaving 640KB Behind" on page 38.) Paradox 386, which is built with Phar Lap's DOS extender, needs 1.5MB of extended memory (512KB less than that required by the OS/2 version). ORACLE, with its proprietary extender, Protected Mode Executive, needs 856KB of extended memory (40KB less than that required under OS/2). Assuming that we replace one of the larger programs running under DESQview with a DOS-extended version, a minimum system configuration would require 3MB of memory.

OS/2 and DESQview swap programs to disk when the physical memory is exhausted, but like overlays, swapping adversely affects performance.

HOW MUCH WILL IT COST?

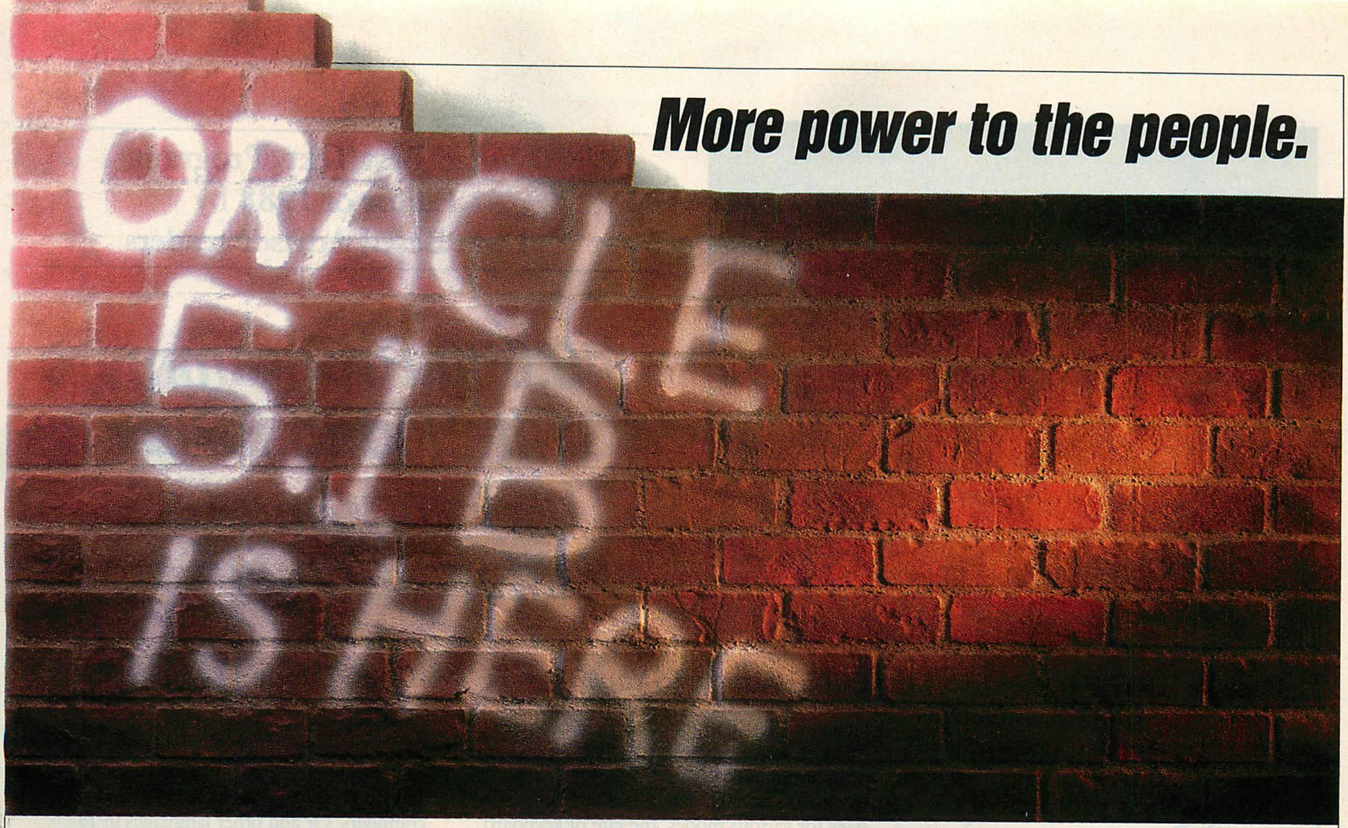
Calculating the cost of memory is not simple. Prices vary depending on the target machine, the capacity of the chips (256KB or 1MB), and the speed of the memory.

Most of today's 286 systems are offered with 512KB on the system board. An EMS-compatible add-in memory board, such as an Intel Above Board Plus or an AST Rampage Plus, can be used as either expanded or extended memory, enabling compatibility with either DESQview or OS/2. Extended memory can also be added to the system board, when possible, or on an add-in board.

Most 386 systems will accept several megabytes of memory on the system board and hold additional memory in proprietary slots. Normally, memory for these machines must be acquired from the system vendor. EMS hardware support is not necessary, since memory managers such as Qualitas Software's 386-to-the-Max or DESQview's QEMM emulate expanded memory by using the 386's virtual 8086 mode.

If you want to multitask several programs, you must buy some memory. Regardless of which method you choose, the difference in memory requirements between an OS/2 system and one running DESQview is not 4MB—it's merely 1 to 1.5MB. Depending on the type of memory, this translates into a list-price difference of $600 to $1,100 per megabyte.

More power to the people.



ORACLE has led a revolution in PC relational database technology. More power. More portability. More connectivity. More reasons than ever to make ORACLE your corporate standard database.

PC MAGAZINE EDITORS' CHOICE

New tools with even more power.

We're proud to announce our newest release—Professional ORACLE Version 5.1B. Now you can run your applications in OS/2 or in protected mode above 640K in MS-DOS. So you have more room for more powerful applications. And those same applications run unmodified on almost all workstations, minicomputers and mainframes.

Version 5.1B delivers a new level of power to your PC developers including the latest versions of:

- SQL*Forms® NEW! Enhanced 4th-generation application development environment.
- SQL*Menu® NEW! Flexible interface builder for defining complex menu systems.
- SQL*ReportWriter™ NEW! Non-procedural development and runtime powerhouse for producing any report.
- SQL*Plus® Oracle's ANSI-standard SQL query and administration tool.
- Pro*C™ The C-language pre-compiler and subroutine call interface to ORACLE.

Learn SQL on us.

Learn the language of the revolution. Order Professional ORACLE today for $1299 and we'll include ORACLE SQL*Tutor, a nine-module PC-based SQL instruction program that sells by itself for $199.

Try ORACLE for $199.

Our Trial Version is identical to Professional ORACLE, but can't be used in networked configurations and allows a maximum user database size of 1 MB. It's a powerful tool for prototyping your first ORACLE application. And its price can be applied to the purchase of a full Professional ORACLE license.

ORACLE®

COMPATIBILITY · PORTABILITY · CONNECTABILITY

Call 1-800-ORACLE1, ext. 4831 today.

Money-back guarantee.

If you haven't tried ORACLE yet, now there's even more reason to join the SQL revolution. More tools. More power. If ORACLE 5.1B doesn't revolutionize the way you develop PC database applications, return it within 30 days for a full refund.

Call 1-800-ORACLE1 ext. 4831, or an ORACLE MasterVAR today.

Dear Oracle

Oracle Direct • 20 Davis Dr. • Belmont, CA 94002
1-800-ORACLE1, ext. 4831

Since your 30-day money-back guarantee eliminates any risk on my part, please send me the software below. Enclosed is my ☐ check, or ☐ VISA ☐ MasterCard ☐ AmEx credit card authorization. Offer valid only in the USA.
Please send ☐ 5.25" High Density or ☐ 3.5" disks.

☐ Professional ORACLE for MS-DOS with free ORACLE SQL•Tutor for $1299 .... $______

☐ Professional ORACLE for MS-DOS Trial Version for $199 .... $______

☐ Professional ORACLE for OS/2 for $1299 .... $______

Professional ORACLE Requirements: **MS-DOS**—80286/80386 PC with MS-DOS V3.1+, hard disk, 640KB of memory and 896K extended memory required. 2.5MB of extended memory recommended (required for SQL•ReportWriter). **OS/2**—80286/80386 PC w/ OS/2 V1.0, hard disk, 3MB memory. SQL•ReportWriter not available for OS/2 and is replaced by SQL•Report®

☐ Just send ORACLE SQL•Tutor for $199 .... $______

Minimum Requirements: 256K PC with hard disk. Color monitor suggested.

Subtotal .... $______

Please add appropriate sales tax .... $______

Total enclosed/authorized (USA only) .... $______

NAME ______ TITLE ______

COMPANY ______

STREET *(no P.O. boxes, please)* ______

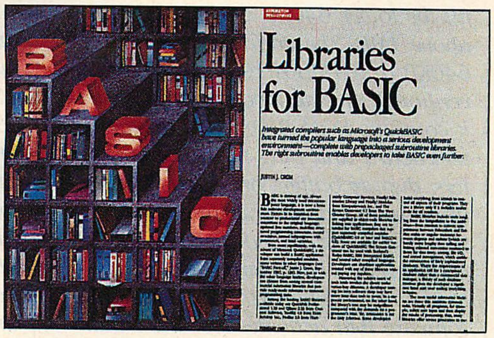
CITY ______ STATE ______ ZIP ______

PHONE ______

CREDIT CARD NO ______ CARD EXPIRATION DATE ______

SIGNATURE ______ TODAY'S DATE ______ **PC.TECH.JRN**

LETTERS



DON'T WORRY, HLLAPI

The article on HLLAPI ("The High Road to Host Connectivity," Michael Triner, January 1989, p. 85) was the best I have seen, but I would like to clarify one point on memory consumption. Although it is true that the E78 emulation program from Digital Communications Associates (DCA) uses less memory than Attachmate's EXTRA!, it is not a valid comparison. EXTRA! is a multisession, extended-function program, while E78 is a single-session emulator similar to our entry-level program. DCA's DFT program listed at the end of the article is a closer comparison, but it consumes about 70KB more memory than EXTRA!.

It may interest your readers to know that Attachmate conducts seminars for programmers that cover HLLAPI functions, along with some real-world examples of how different organizations are putting it to work.

Mike New, vice president
Attachmate Corporation
Bellevue, WA

BEHIND THE SCREEN

I am a long-time reader and advocate of *PC Tech Journal*. I believe it is one of the best available sources for current PC technical information. It is my single most used source for finding information on software development tools.

When you asked if we at The West Chester Group were interested in having The Screen Generator (SG) included in a review of BASIC libraries, we welcomed the opportunity. Unfortunately, the resulting article ("Libraries for BASIC," Justin Crom, February 1989, p. 91) contains several omissions and statements that tend to be misleading.

In table 1, a comparison of library services, the following line-item features should have been included as features of SG: data entry by field, date and time functions, keyboard control, menus, pop-ups, and window management. Giving the package credit for only one feature, as opposed to the seven it includes, suggests discrepancies between the reviewer's analysis and what the package actually offers.

His comment, "field lengths and row/column positions are passed to SG, not as numbers, but as ASCII codes," is out of context and implies that this information must be passed to SG for all fields defined on a screen, when in fact this information is passed automatically via the user's predefined screens.

He also states, "calls to The Screen Manager seem unwieldy," when they are consistent, and "West Chester provides no source code," when, in fact, all of the sample source is included. In addition, support is free and normally provided Monday through Friday, 9 a.m. to 5 p.m. (Eastern)—not the next day as stated in the article.

Kevin Smith, president
The West Chester Group
West Chester, PA

As table 1 in the article reflects, The Screen Generator is exclusively for data-entry screens. The single category marked for SG was intended to show that multiple field input could be handled in contrast to single-field data entry. The other features of SG claimed by Mr. Smith exist only within the context of data entry. For example, consider the claim to date and time functions: SG will perform date format input validation—a data-entry task. If, however, a developer needs a routine to calculate the number of days between two dates, SG would be unsuited, whereas other libraries contain routines for date and time arithmetic.

In preparation for the article, I conducted an extensive review of product features. Table 1 was intended to be an abbreviated overview of material contained in the text.

The article's comment about passing values to SG as ASCII codes takes nothing out of context. The SG user manual shows 40 percent of The Screen Manager's options with BASIC code containing row/column value-passing as described in the article. Indeed, the use of ASCII code in every call to the screen manager is a hallmark of SG's BASIC implementation.

In mentioning the absence of source code, I was referring to source code for the main SG routines. By not providing source code for their routines, West Chester denies developers the opportunity to customize the routines. I mentioned West Chester's provision of sample BASIC code in the article.

My experience with West Chester's technical support was accurately portrayed in the article. A call to West Chester at 11:51 a.m. EDT on October 10, 1988, was answered by machine. Mr. Smith returned the call himself the next morning with accurate, courteous assistance.

—Justin Crom

EXPANDED OR EXTENDED?

I was enjoying "DOS Marches On" (Richard Wilton, January 1989, p. 98) and came across a confusing line regarding expanded and extended memory. Under the section describing expanded memory, the author describes the PS/2 Model 60 configured with 1MB of RAM as 640KB of conventional memory and 384KB of extended memory. To my understanding, extended memory is memory over 1MB, and the memory between 640KB and 1MB can be used as expanded memory.

Cameron T. Brett
Zenith Data Systems
Chelmsford, MA

Extended memory, available only on 286 and 386 systems, resides above the 1MB boundary and is directly addressable by the CPU in protected mode. Extended memory can be present even if the lower megabyte is not totally populated. IBM-compatible machines with 1MB or more (such as the Model 60)

fill the lower 640KB and place the rest above 1MB. The address space between 640KB and 1MB does not contain conventional or extended memory; instead, it contains ROM BIOS code on the system board and plug-in device controllers, display buffers on video adapters, and expanded-memory page frames supplied by expanded memory specification (EMS) hardware (on 386 systems, page frames can be provided by software that activates the CPU's built-in paging capability).

Expanded memory does not reside in the area above 640KB, but totally outside of the system's address space; 16KB sections of it can be made to appear in page frames defined in the first megabyte. How much expanded memory appears at a time depends on the number and location of the page frames; that in turn depends on the EMS version and the system configuration. EMS versions prior to 4.0 were limited to four page frames above 640KB; subsequent versions of EMS and all versions of enhanced EMS (EEMS) can have as many as 50 frames anywhere in the first megabyte not populated by conventional, display, or read-only memory.

To make an analogy between memory and auxiliary storage, extended memory is like a hard disk—all of it is continuously available to the system. Expanded memory is like a drive with removable media—the system can access only the portion currently mounted, and needs the intervention of a special agent—the expanded memory manager (EMM)—to access other portions. —*TM*

JUST A SMALL BUG

Thank you for reviewing our V-RAM VGA in the January 1989 issue of *PC Tech Journal* ("The VGA Parade," Kent Quirk, p. 70). It was, by and large, a well-written and thoughtful article.

I would like to point out, however, that some of Mr. Quirk's comments may have been a little extreme. In particular, his comments regarding the operation of our products in monochrome mode are much more a reflection of test performance than of actual performance. While we do have a small bug, it is undetectable by the user. I believe that benchmark tests such as VGATEST are fine for the first pass, but their results tend to be dominated by FOR loops and binary answers. Results of a benchmark test must be checked against real-world applications. If Mr. Quirk had done so in this case, he would have found that the variance between our parameters and those provided by IBM are great, but, in fact, produce no visible difference at all. Therefore, we find his comment that "Tatung and Video Seven boards . . . have unacceptable failures in monochrome mode" to be highly suspect.

Greg Reznick
Video Seven Inc.
Fremont, CA

The size of a bug has nothing to do with the size of the error it can produce. The specific bug that Mr. Reznick refers to results in disregarding the blue level while calculating shades of gray. This means that any colors differing solely in their relative percentage of blue will be indistinguishable on the Video Seven VGA. Although the company claims that this error has no effect on the user, that may not always be true. In fact, I often use light blue on a dark blue background as an easy-on-the-eyes set of screen colors; the Video

Creative License.

If you've ever tried to combine windows, menus, forms, and text entry to create an effective user interface, you know how challenging it can be.

Perhaps you've turned to a third-party library for help. Only to run into restrictions, limitations, and dead ends. So you had to compromise your design. Or modify the library source code. Or start over.

Which is precisely why we designed Vermont Views™, the new generation of Windows for Data®, the best-selling C library for user interfaces.

Vermont Views offers unbridled, unrestricted creative license.

The Human Interface Of Your Dreams

Vermont Views offers an unparalleled set of interface building blocks that you can combine in unlimited ways:

- Menus can be created in any style you choose, made scrollable vertically and horizontally, and nested to any level. Features include n-th character selection, checkmarks, and unavailable items.
- Data entry forms can be bigger than their display windows, have scrollable regions for the entry of variable lines of items, lists of choices for data entry, context sensitive help, and special decimal, date, time, and toggle fields.
- A mini word processor can be attached to a field window in a form or used as a pop-up note taker.

You're In Charge

Because you can write and attach functions to the beginning and end of menus, forms, fields, and to keys, you're always in control.

Use these control functions to call up subsidiary forms and menus, change field values and the active field, exit or abort a form, do almost any task you can imagine.

All interactive capabilities of Vermont Views use a unique system of accessible keytables, so you can easily change or disable key assignments – even add to the functions provided for menus, forms, text entry, and windows.

One For All

Vermont Views is available for DOS, OS/2, UNIX, XENIX, and VMS. Maintain the same user interface on all of these operating systems with the same source code.

Vermont Views provides international portability as well, with full support for IBM international characters, flexible date and time formats, and changeable decimal and thousands separators.

Novice Or Expert

Despite its depth and flexibility, Vermont Views is easy to learn and use. Each major facility is covered in a single, self-contained section of the manual, so you only need to learn capabilities as you use them.

To help you become an expert in no time, we include a free copy of the Norton Guides™ Engine and our own comprehensive Pop-Up Reference™. You'll have immediate, on-line access to function names, reference pages, structures and tables.

No-Time-Limit Guarantee

We've only touched on a fraction of what makes Vermont Views special. The only way to know it is to use it.

Try Vermont Views on your hardest problems.

For as long as you want. At no risk.

If not fully satisfied, return for a full refund. Anytime.

To Order Today Call 1-800-848-1248

Call to order Vermont Views today. And we'll send your "creative license" right away.

Prices: DOS $395; with Source $790. UNIX, XENIX, VMS, OS/2 please call.

Vermont Creative Software

Pinnacle Meadows, Richford, VT 05476

800-848-1248, 802-848-7731 Fax: 802-848-3502 Telex: 510-601-4160 VCSOFT

Seven board renders this combination invisible on a monochrome monitor. Because boards from competing manufacturers are available that handle this combination correctly, I consider the Video Seven board's performance to be unacceptable for anyone constrained to monochrome.

I took pains to point out in the article that most of the errors uncovered for the boards tested were trivial in nature. The Video Seven monochrome bug is not trivial. Commendably, the company has discovered the source of the problem and indicates that it will be fixed in the latest release. If VGATEST has helped them to improve compatibility, everyone concerned has benefitted. —*Kent Quirk*

DEBUGGING AT THE SOURCE

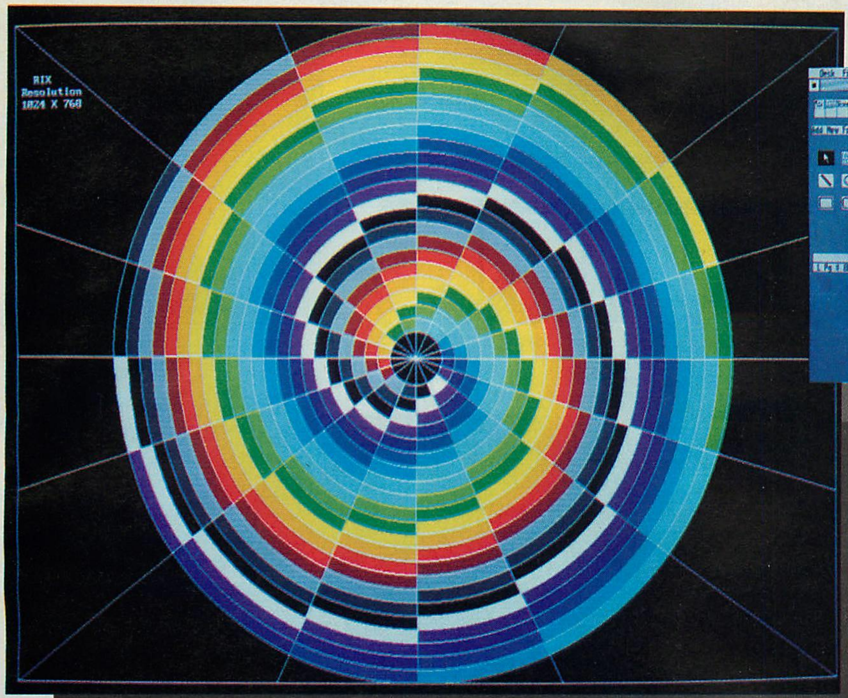
This letter is in response to the January 1989 reader poll on testing and debugging techniques. Some of the best solutions come from entering debugging code directly into the source code before compilation. Viewing the variables and their locations can give me enough data to convert the bug into working code. Although it is harder to trace steps while debugging in this manner, displaying the procedure and function names when called upon, along with their local and global variables, are enough to debug the program.

The debugging issue, however, may seem to surprise someone using this method while calling libraries or units, which can display information only before and after the call, unless debug code was built around the precompiled subprogram.

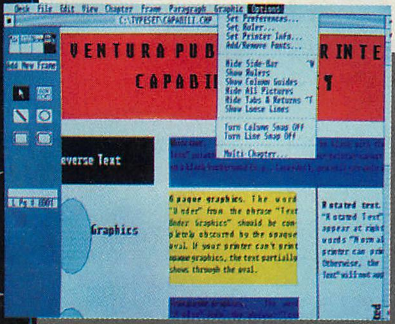
This method creates no overhead, allowing you to create as large a program as your memory can hold, and it allows you to keep total control of the program flow. I have had too many debuggers that tend to lock up during trace mode or watch-variable mode. After running this a few times in the debugger, and getting discouraged, I went to the old style of placing watch code within the program.

A good debugger is the one built into the Microsoft Quick environment, such as QuickBASIC and QuickC. A few flaws, however, still remain in that debugger, forcing me back to the debug code format. Even though debuggers are becoming more advanced, they still don't offer the security that I need.

Jeff Booher
Que Corporation
Indianapolis, IN

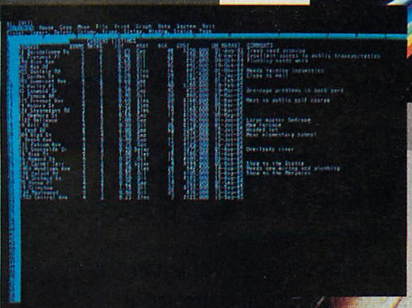


1024 x 768



800 x 600

640 x 480



132 Columns

320 x 200

Super VGA Resolutions

... are brought to you by the **ATI SYSTEMS PRISM®** series of VGA graphics adapters. The PRISM is an advanced VGA that redefines the VGA standard by offering MORE COLORS, HIGHER RESOLUTION, and FASTER SPEED while providing TOTAL REGISTER LEVEL compatibility with all previous graphics standards-including Hercules® at a very affordable price!

COLORS AND RESOLUTIONS. With 512Kb of video memory the PRISM supports 256 simultaneous colors in 640x400 and 640x480 resolutions, and offers 16 colors in 800x600 and 1024x768 resolutions. With the standard 256Kb of video memory, the PRISM supports 256 colors in 320x200 and 640x400 resolutions, 16 colors in 640x480 and 800x600, and 2 colors in 1024x768 resolution. BEST OF ALL, should you purchase a 256Kb version of the PRISM, you can update it at a later date as each PRISM has sockets for additional memory. OF COURSE, the PRISM supports 132 Columns by 25, 30, 44, or 60 rows. SOFTWARE DRIVERS for the most popular programs are included at no extra charge. And, all of these features are available whether you choose the 8-bit or 16-bit PRISM.

SPEED. The PRISM VGA is supplied with ATI SYSTEMS' exclusive shadowRAM®, a utility that increases the PRISM's video speed whether it's an 8 bit or 16 bit model. Simple to install, shadowRAM allows video speed increases of over 400% when compared to the IBM VGA Display Adapter®.

EXTRAS. Every PRISM is supplied with autoBUS®, autoDETECT®, and autoSELECT®. The PRISM AUTOMATICALLY senses the host bus, type of monitor and software configuration allowing easy, trouble free use.

GUARANTEE. The PRISM VGA is provided with a LIFETIME guarantee. If the PRISM should ever fail, simply return it for a replacement.

Advanced Technology
Information Systems

5309 Randall Place, Fremont, CA 94538
415-490-9360; Fax:415-490-9342

CIRCLE NO. 125 ON READER SERVICE CARD

INSTANT MAINFRAME. JUST ADD SCO.

Not too long ago, a few dozen people sharing the same programs, resources, and information on a single computer at the same time meant only one thing—a mainframe.

Powerful, big, expensive, and proprietary.

More recently, the same people could be found doing exactly the same things—simultaneously sharing programs, resources, and information—on a minicomputer.

A lot cheaper, a lot smaller, yet powerful enough to do the same jobs. And just as proprietary.

Then along came the latest generation of personal computers. And now, the same people are more and more likely to be found doing exactly the same things—simultaneously sharing programs, resources, and information—on a PC.

And not a whole officeful of PCs networked together, either, but *a single PC powering the whole office at once.*

A *lot* cheaper, a *lot* smaller, yet still easily powerful enough to do the same jobs. Built to non-proprietary, open system standards that allow complete freedom of choice in hardware and software.

And running the industry-choice multiuser, multitasking UNIX® System V platform that gives millions of 286- and 386-based PC users mainframe power every business day.

The UNIX System standard for PCs—SCO.™

The SCO family of UNIX System software solutions is available for all 80286- and 80386-based industry-standard and Micro Channel™ computers.

Today, SCO UNIX System solutions are installed on more than one in ten of all leading 386 computers in operation worldwide.

Running thousands of off-the-shelf XENIX® and UNIX System-based applications on powerful standard business systems supporting 32 or even more workstations—at an unbelievably low cost per user. And with such blazing performance that individual users believe they have the whole system to themselves.

Running electronic mail across the office—or around the world—in seconds.

Running multiuser PC communications to minis and mainframes through TCP/IP and SNA networks.

And doing some things that no mainframe—or even DOS- or OS/2™-based PC—ever thought about, such as running multiple DOS applications. Or networking DOS, OS/2, XENIX and UNIX Systems together. Or running UNIX System versions and workalikes of popular DOS applications such as Microsoft® Word, 1-2-3®, and dBASE III PLUS.®

Or even letting users integrate full-featured multiuser productivity packages *of their choice* under a standard, friendly menu interface.

Today's personal computer isn't just a "PC" anymore, and you can unleash its incredible mainframe-plus power for yourself—today.

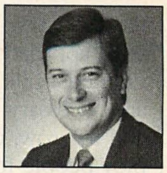
Just add SCO.

See us at Comdex/Spring '89
Booth #2850

SCO™
THE SANTA CRUZ OPERATION

(800) 626-UNIX (626-8649)
(408) 425-7222
FAX: (408) 458-4227
E-MAIL: ...!uunet!sco!info info@sco.COM

CIRCLE NO. 117 ON READER SERVICE CARD



NEW DIRECTIONS

AST Ascending

Through determination and quality products, AST has become an exceptional computer systems supplier.

In spite of the critical acclaim accorded its Premium/286, AST Research has suffered mightily at the hands of the press. One might almost be given to believe that AST's attempt to transform itself from an enhancement product manufacturer to a general systems company was somehow an affront to those who said it could not be done (almost everyone was skeptical) and that the microscopic examination of AST's every step was an analyst's revenge, one followed in detail by the ever-circling fourth estate.

To be sure, AST's transformation from an enhancement company to a full-line systems supplier has not been entirely smooth, with mistakes in marketing and manufacturing, a different (and somewhat confusing) distribution strategy, and financial losses in the first six months of the current fiscal year. Notwithstanding that AST was a $400 million company last year and may break $500 million for fiscal 1989, the profit picture may be cause for concern; a December 1988 report from Bear, Stearns & Company estimates the net profit after taxes at a slim one percent, comparing unfavorably to an industry-wide average of 7.4 percent.

Can AST make it? Personally, I think the financial information, which forms the basis for much of the news reports on the company, is less important than it sounds. Why? For one reason, the three founders of AST together own just over 51 percent of the company. Although they no doubt want to please their stockholders, their control gives them the opportunity to set long-range plans instead of dancing to the tune of short-term profit takers or trying to please Wall Street analysts.

For another reason, the transition AST has made was expensive, particularly because it was accomplished with such speed; it has tended to reduce AST's cash position and raise its debt ratios, yet it was necessary if the company was to be taken seriously in the systems market.

Yet another reason: some steps AST has taken to contain costs and get its systems business moving have not yet had effect. A reduction in its work force is recent. Currently, not all the systems are shipping. AST has expanded its retail channel, but not all authorized dealers are selling AST computers on a regular basis. AST is now focusing on its core businesses; its Cammintonn division (DEC enhancement products) is for sale and all its product lines have been streamlined.

The only management issue that concerns me is the nature of AST's distribution strategy. Unlike Compaq (authorized dealers only) or IBM (dealers, direct sales to its large systems customers), AST caters to almost every possible channel, including distributors and direct sales to smaller retailers. The company has been particularly successful in attracting value-added resellers and dealers (VARs and VADs), ranking number one in a recent *Computer Reseller News* study. AST cofounder and executive vice president Tom Yuen says that the company has 4,813 certified dealers signed up world-wide, although he admits that not all of these dealers are actively pushing AST systems yet.

Analysts have criticized AST for putting together such a shotgun distribution strategy because retailers are fickle, especially if they feel undercut by the same products flowing through other channels, primarily gray-market discounters. Given Compaq's success at catering to retailers, there is probably some substance to those fears. I understand, however, AST's strategy in one important respect. If its machines are to compete side by side on the same shelf with IBM and Compaq, the machines have to get on the shelf in the first place. It is very difficult to convince a retailer to take on a new computer line because of the training, support, and inventory that must be maintained. Therefore, AST has to create a demand for its systems in any way it can in order to create the desire for its products on the part of the most important retailers. Anyway, 4,813 dealers are certainly nothing to sniff at.

GUTS BALL

One thing I admire most about AST is its dedication to the principle of long-range thinking and planning. That may be another reason why the financial press is not always friendly; stockholders and their agents on Wall Street seem chronically interested in the short

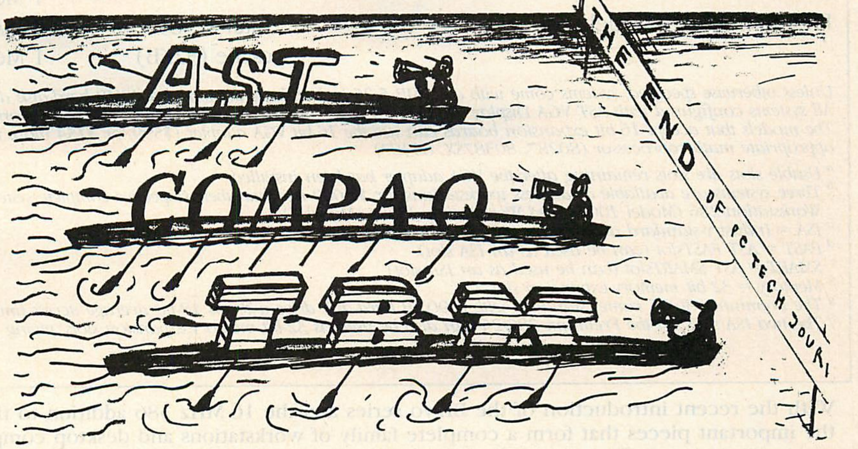


ILLUSTRATION • MACIEK ALBRECHT

term. My own thinking is that short-term approaches allow profits to be drained while long-term approaches are necessary for companies to build and to grow, companies that will employ people for the long haul and, hopefully, innovate for the long haul. In many cases, the reports prepared by the financial community are long on technical financial analyses, but embarrassingly short on conceptual understanding of the underlying technology or the business strategy. For example, the Bear, Stearns & Company report I read says that AST must establish a reputation for innovative products "such as the 25-MHz 386 system"; while I don't mean to berate this particular computer, I think AST's Workstation family and the new Premium 386/16 are more innovative, more interesting, and actually more important for the company. The 386/25 is simply a system AST *had* to build to have a full line and be fully competitive. The Bear, Stearns report has other, similar flaws.

What is AST's strategy? Its specific goal—to be the number one alternative to IBM and Compaq—was stated when the Premium/286 was announced two years ago and is still in effect. AST is making steady (not spectacular, but steady) progress towards that goal. The best measure of the success to date is the financial result for the second quarter that ended in December 1988.

Revenues were $110 million, of which 80 percent came from computer systems. Approximately 15,000 computers (75 percent of which were 286-based) were sold during that period. According to Tom Yuen, 286 sales are stable and 386 sales are growing steadily. Yuen expects to sell at least 250,000 systems this year; AST has sold 350,000 in the first 20 months of its systems business. Compared with any company's results in its early years, this is an impressive performance.

The desktop market is currently in an extraordinarily competitive period and is thus very volatile. Nonetheless, I think AST is going to achieve its goal with its cost-effective, quality products that are backed by a dedicated management—a team that has learned many lessons the hard way.

THE SYSTEMS

Today, AST's computer systems bear only a superficial resemblance to the product line of one year ago. Before, only the Premium/286 and the late-to-market and now-discontinued Premium/386 were available; today, a complete family of competitive desktop computers has been placed at every price and performance point (see table 1). The line has recently been fleshed out with AST's entry-level machine, the 286-based, 8-MHz, zero-wait-state Bravo/286 with a list price of $1,095 (for the base model), as well as a new, 16-MHz 386-based machine in the more-important Premium series.

If anything is wrong with the product line, it is that it includes too many 286-based systems (three out of seven), but the flagship Premium/286 is probably nearing the end of its life because it is being squeezed by AST's own Workstation/286 from below and the Workstation/386SX from above; in addition, the Premium/286 requires AST's expensive FASTRAM memory boards to retain its performance advantage as memory is expanded.

The new Bravo/286 system received quite a bit of press coverage even before it was officially announced. It has been called AST's answer to pressure from other so-called "second tier" vendors, especially Japanese and Korean imports. I think it fills a much simpler role. The relatively expensive Premium/286 is aging and the Workstation/286 has only two slots, so AST now offers its least-expensive machine with about a 10-MHz performance rate (due to zero wait states), three slots, and a reasonably fast (28 ms) 40MB hard disk. It is a machine that competes directly with the IBM Model 30 286-E21, which at $3,280, offers about the same performance (10 MHz, one wait state), the same number of slots, but a 20MB hard disk with a much slower access time (80 ms).

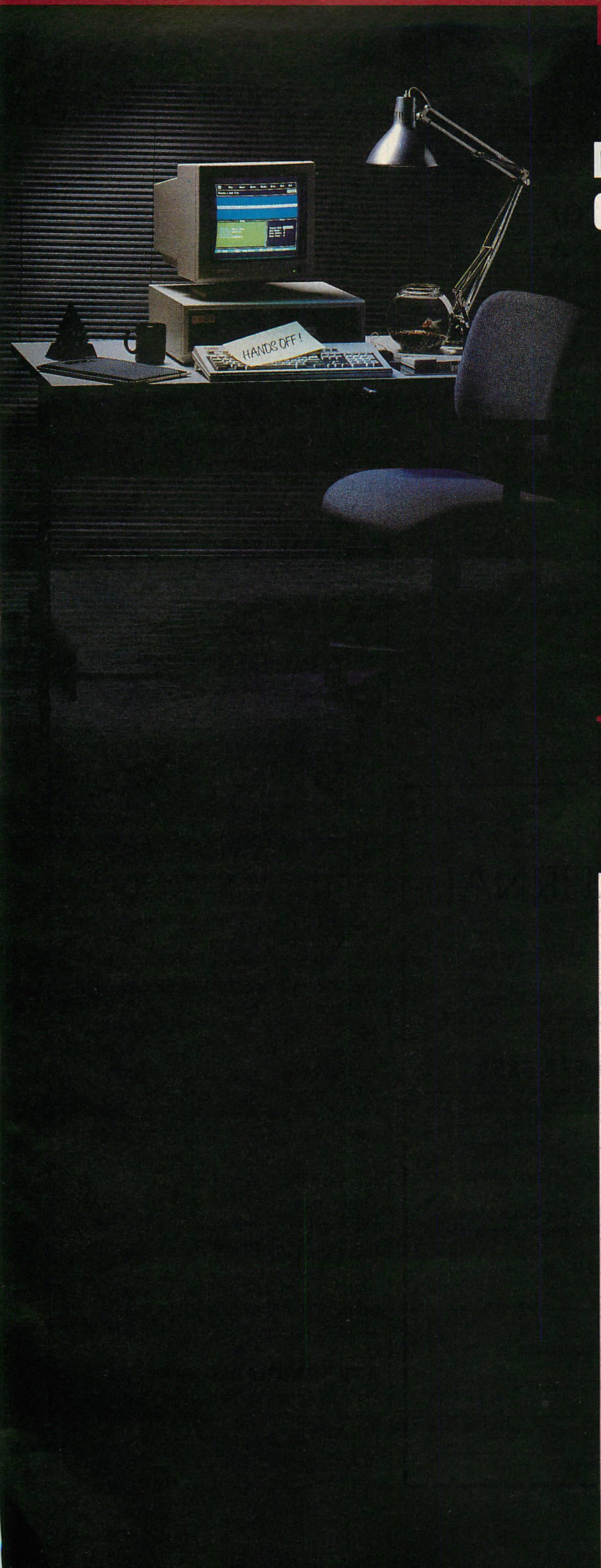
TABLE 1: ***Price Positioning of AST Product Line***

	CPU CLOCK RATE (MHz)	MEMORY PERFORMANCE	USABLE SLOTS[a]	STANDARD MEMORY	PRICE
Bravo/286 Model 45[b]	8	Zero wait states	3 ISA[c]	512KB	$ 3,235
Workstation/286 Model 145x[b]	10	One wait state	2 ISA	512KB	3,490
Premium/286 Model 140V	10	Zero wait states	4 ISA, 2 FAST[d]	1MB	4,790
Workstation/386SX Model 45[b]	16	32KB cache	2 ISA	1MB	5,190
Premium 386/16 Model 45	16	64KB cache	5 ISA	1MB	5,535
Premium/386C Model 340	20	64KB cache	2 ISA, 3 SMART,[e] 1 Memory[f]	1MB	6,635
Premium 386/25 Model 95[g]	25	Intel 82385 cache (32KB)	2 ISA,[h] 3 SMART, 1 Memory	2MB	10,135

Unless otherwise specified, systems come with a 1.2MB 5.25-inch diskette drive and a 40MB hard-disk drive with an average access time of 28 ms. All systems configured with AST VGA Display ($695) and AST 8-bit VGA adapter ($445), except for workstations, which include AST-VGA Module ($300). The models that accept 16-bit expansion boards can use the 16-bit VGA adapter ($599, or $154 more than total shown above). All models support an appropriate math coprocessor (80287, 80387SX, 80387).

[a] *Usable slots are slots remaining after the VGA adapter has been installed.*
[b] *Three systems are available as diskless workstations for $1,000 less than their respective complete system price: Bravo/286 (Model 1), Workstation/286 (Model 100x), and Workstation 386SX (Model 5)*
[c] *ISA = Industry-standard architecture (16-bit, AT-bus compatible).*
[d] *FAST = AST FASTslot (can be used as an ISA slot).*
[e] *SMART = AST SMARTslot (can be used as an ISA slot).*
[f] *Memory = 32-bit memory-expansion slot.*
[g] *The Premium 386/25 comes standard with a 90MB hard-disk drive with an 18-ms average access time and supports the Weitek 3167 coprocessor.*
[h] *The two ISA slots on the Premium 386/25 can also be used as 32-bit memory-expansion slots, giving the system a maximum memory capacity of 36MB.*

With the recent introduction of the Bravo series and the 16-MHz 386 addition to the Premium line, AST has put into place the important pieces that form a complete family of workstations and desktop computers at a broad range of prices.


HANDS OFF!

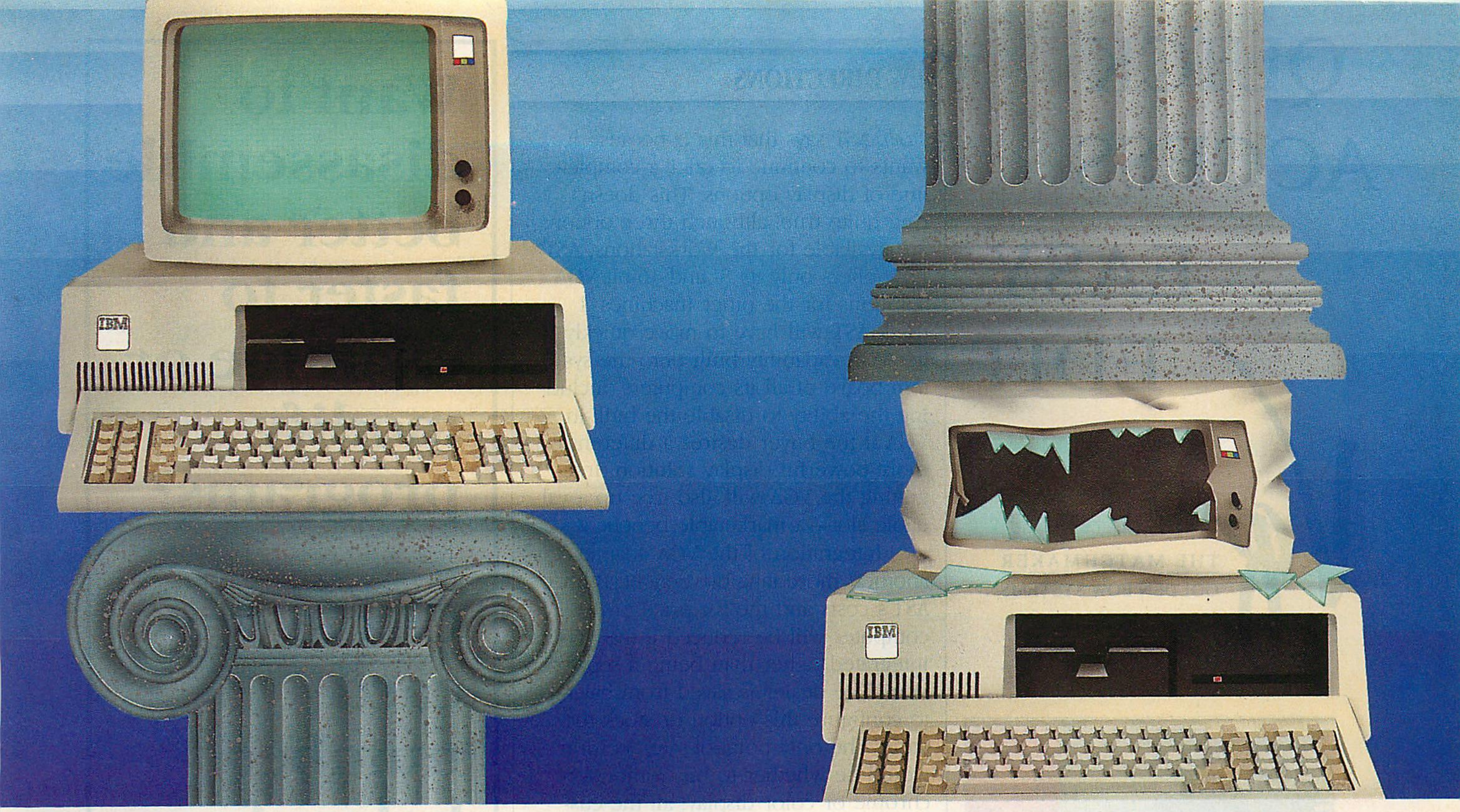
As a matter of fact, the Bravo/286 goes beyond AST's stated goal. Compaq has eschewed the 286 market, so in this particular category, AST is the only brand-name vendor after IBM, an enviable position indeed.

The attention that has been focused on the bottom of AST's line may have caused many to miss an intriguing new 386 system, AST's Premium 386/16. At first glance, a 16-MHz 386 may not seem very exciting, especially in light of Compaq's decision to drop its original 16-MHz Deskpro 386 model from its product line. The AST machine, however, improves on typical 16-MHz performance through the inclusion of 64KB of 45-nanosecond (ns), zero-wait-state cache memory, which boosts the performance of the system to almost the level of a noncached 20-MHz system. As table 1 shows, the VGA-configured price of the 386/16 is $5,535, a very competitive price when compared with IBM's 16-MHz (but not cached) PS/2 Model 70-E61 at $6,680; the extra $1,145 is hardly justified for IBM's 20MB-larger hard disk. The 386/16 also looks attractive compared with the 20-MHz Model 70-121, although a direct comparison is made difficult by the huge difference in hard-disk capacity—the 386/16's 40MB versus the Model 70's 120MB. The 386/16 configured with 2MB of RAM will probably be about $6,185 (AST has not announced memory upgrade prices for this machine) versus $8,680 for the Model 70.

The comparison with the Model 70 points to a weakness with AST's new offering. The only disk drive offered on the system is the 40MB unit with an average access time of 28 ms. One reason why the Model 70 is so attractive is the larger drives it can accommodate. Furthermore, an access time of 28 ms, while certainly adequate, does not compare favorably with the performance of the hard disks in Compaq machines (which is as little as 19 ms). I am sure the 386/16 branch of the AST family tree will grow some new leaves; every other system, except the Bravo, has at least two hard-disk options (the 386C offers capacities of 40, 90, 150, and 320MB). AST will soon have to address the hard-disk performance issue, however.

AND NOW THE BAD NEWS . . .

Two nagging problems with AST computers remain. The most obvious is that only the Workstations have an integrated graphics adapter (one that does not consume a standard expansion



QNX® vs. UNIX OS/2

See us at COMDEX/Spring '89
April 10–13, 1989
McCormick Place
Chicago, Illinois
Booth #2843

Architecture can make or break a computer system.

Don't make your systems bear the brunt of massive, monolithic monsters like Unix or OS/2. Instead, build your systems with QNX. The lean, efficient OS that's flexible enough to support any application.

MULTIUSER, MULTITASKING, NETWORKING, AND MORE... QNX is both multiuser *and* multitasking. OS/2 isn't multiuser. Unix may be multiuser and multitasking, but it will hog a huge chunk of your hard disk and system memory. And neither Unix nor OS/2 can do integrated networking.

QNX, on the other hand, hums along using an efficient 150K of RAM, yet provides a powerful multiuser, multitasking, and integrated networking environment.

TRUE DISTRIBUTED PROCESSING. A QNX-based PC LAN lets any user share *any* resource on the network—programs, data, devices, even CPUs—without going through the bottleneck of a central file server. With QNX you get mainframe power at micro prices.

ADDED VALUE FOR VARS. QNX is flexible enough to run on *any mix of* PCs, ATs, PS/2s, with or without dumb terminals. Even diskless workstations are supported. So whether you start small or grow to mainframe proportions, you can easily build and maintain powerful, fault-tolerant systems without spending a fortune on hardware.

REALTIME PERFORMANCE. Only QNX combines the performance of a dedicated realtime executive with the convenience of a rich development environment that includes a host of utilities, C compiler, full-screen editor, symbolic debugger, and multiple full-screen windows.

DOS SUPPORT. For those who need their daily dose of DOS, QNX allows a DOS application to run as a single task on each PC on the network.

FREE TECHNICAL SUPPORT. While users of other operating systems have to cough up hefty fees for support, QNX developers enjoy *free* hotline support and *free* BBS access. You'll get prompt answers to your questions and you'll share ideas and insights with fellow developers in the QNX community.

It's time to make the move to QNX.

THE ONLY MULTIUSER, MULTITASKING, NETWORKING, REALTIME OPERATING SYSTEM FOR THE IBM PC, AT, PS/2, AND COMPATIBLES

Multiuser	10 (32) serial terminals per PC (AT)
Multitasking	64 (150) tasks per PC (AT)
Networking	2.5 Megabit token passing. 255 PC's and/or AT's per network. Thousands of users per network.
Realtime	4,250 task switches/sec (AT).
Message Passing	Fast intertask communication across the network.
C Compiler	Standard Kernighan and Ritchie.
Flexibility	Single PC, networked PC's, single PC with terminals, networked PC's with terminals. No central servers. Full sharing of disks, devices and CPU's.
PC-DOS	PC-DOS runs as a QNX task.
Cost	From US $450. Runtime pricing available.

QNX

For further information or a free demonstration diskette, please telephone (613) 591-0931.

Quantum Software Systems Ltd. • Kanata South Business Park • 175 Terrence Matthews Crescent • Kanata, Ontario, Canada • K2M 1W8

CIRCLE NO. 181 ON READER SERVICE CARD

slot). AST says that this is because it wants to continue to offer a complete line of display options. This doesn't ring quite true; although three options are available for the Workstations, AST now offers only its 8- and 16-bit VGA solutions for the other machines. I think AST will have to move quickly to get VGA capability built onto the system board of all its computers, including the ability to disable the built-in VGA if the buyer desires a different or more-powerful display solution. Integrating the VGA will also free up a valuable slot—a marketable benefit.

Integration of the VGA adapter has another, more tangible benefit. Both AST's costs and the list price of the computer will be reduced if the VGA is integrated rather than being a separate item. The dealer is saved from having to configure this option or stock the parts. The only point-of-sale decision would be whether to buy a monochrome or color display; all the customer has to do is plug in the monitor.

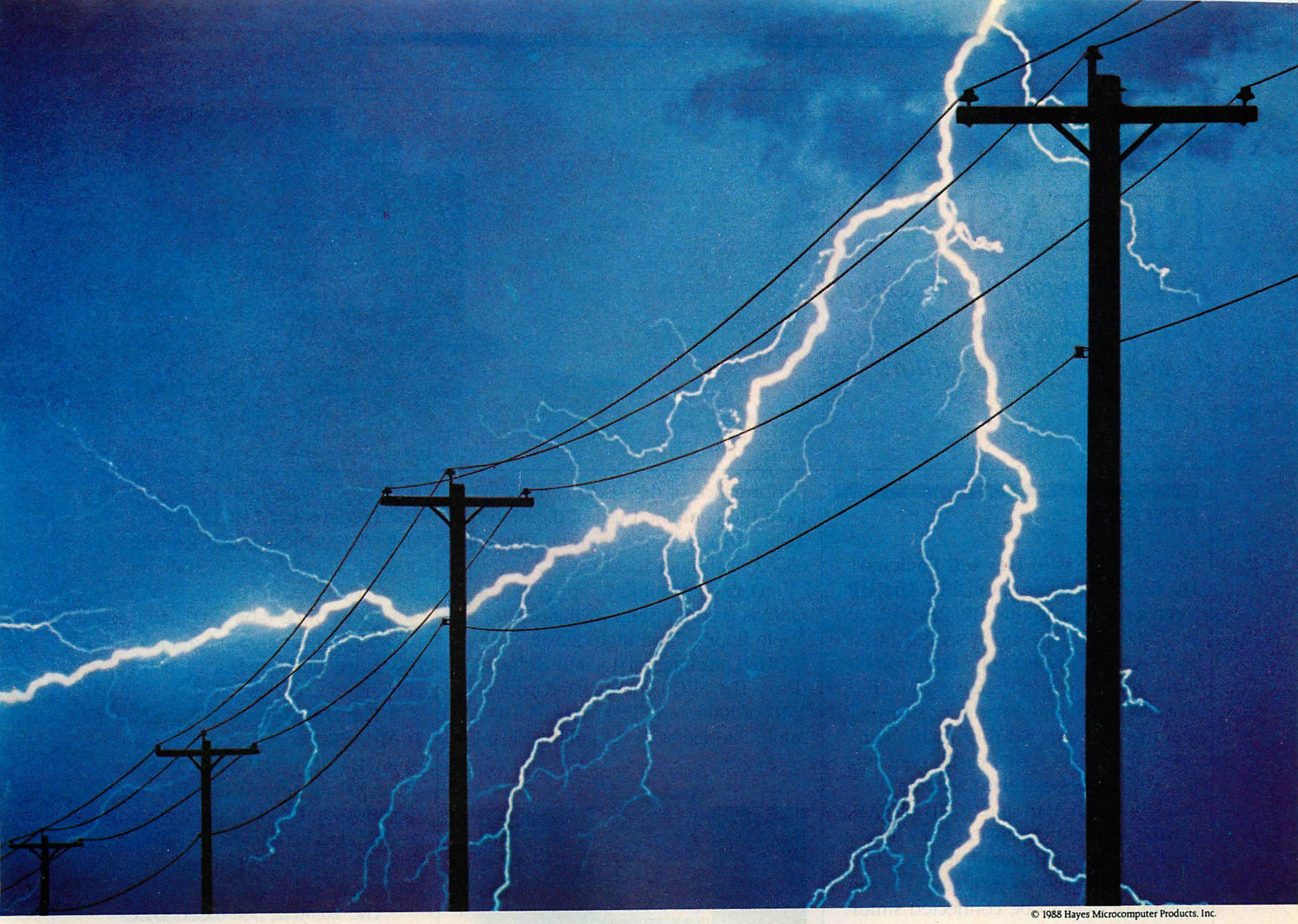
The second omission is the mouse port. IBM has it, Compaq has it on its new form-factor machines (the 386 S and 386e), but AST lags behind. I'm surprised that this slipped through the cracks; it is a small thing, but it will become increasingly important. It will hurt AST later because IBM and Compaq will have amortized the cost of their development, while AST will have to build in that cost to cover its research and development investment.

Both of these complaints are small and mentioned only because they directly relate to AST's goal to be the number-three brand-name vendor. Small omissions such as these may not make a substantial difference in real terms, but they can always be blown way out of proportion in a sales situation, to AST's disadvantage.

These problems notwithstanding, the AST computers represent excellent price/performance points and good value. They are well-built, exhibiting the same quality that has characterized AST's enhancement products for so many years. They even appeal to me on a personal level—I'm a die-hard IBM keyboard fan, and I actually like the feel of AST's keyboard (Compaq's are too soft and squishy for my taste).

For anyone who is integrating systems in their organization, AST computers are a must for evaluation. I think you'll be impressed.

Will Fastie is the editorial director and founding editor of PC Tech Journal.

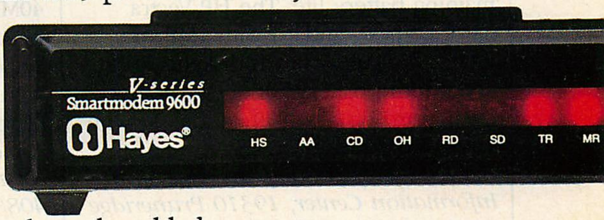


ERROR-CONTROL FOR FORCES BEYOND YOUR CONTROL.

The hazards faced by your high-speed data can be truly shocking.

That's why, in addition to providing the original V-series™ error-control, Hayes V-series 2400 and 9600 bps modems now offer error-control in either international standard, V.42 or X.25.*

The V.42 protocol, for point-to-point communications, automatically detects errors and then retransmits the data correctly. While the X.25 protocol not only offers error-control but also multisession access to value added networks with expanding applications for dial-up X.25 point-to-multipoint communications.



V-series modems still provide users with data compression that can double throughput. And Hayes AutoSync for built-in synchronous communications without the added expense of a synchronous adapter card.

All to give you more control. Because with a Hayes, the only error you can make is not buying one.

Hayes®

For your nearest Hayes Advanced Systems Dealer, call 800-635-1225. Hayes Microcomputer Products, Inc., P.O. Box 105203, Atlanta, GA 30348.

*There will be a minimal charge of $50 for either an X.25 or V.42 upgrade on products purchased before October 1, 1988. Products purchased on or after October 1, 1988 will include either standard as they become available. For details call Hayes Customer Service: 404-441-1617.

CIRCLE NO. 180 ON READER SERVICE CARD

TECH RELEASES

The latest in hardware, software, and technology for systems developers and integrators

Digital's DOS-compatible DECstation 320

SYSTEMS

Three additions to **Hewlett-Packard**'s HP Vectra family are available. The **HP Vectra RS/20C** and the **RS/25C**, based on Intel's 386, operate at speeds of 20 and 25 MHz, respectively. Both come with 1MB of RAM, a 1.2MB 5.25-inch diskette drive, and a memory subsystem that includes 32KB of cache memory and an Intel 82385 cache controller. The processor board accommodates between 1MB and 16MB of RAM, leaving all eight expansion slots free. A Hewlett-Packard Human-Interface Link (HP-HIL) port allows as many as seven HP-HIL devices to be connected simultaneously without using an expansion slot. HP Vectra RS/20C with 1MB of RAM, a 1.2MB 5.25-inch diskette drive, and a 103MB hard-disk drive, $7,595; HP Vectra RS/25C with 1MB of RAM, a 1.2MB 5.25-inch diskette drive, and a 103MB hard-disk drive, $10,295.

Weighing 10.5 pounds without the battery, the **HP Vectra LS/12** laptop is equipped with a 10-inch, backlit liquid-crystal display (LCD). It has a text resolution of 640-by-400 pixels for increased screen readability. The detachable nicad battery lasts up to four hours and weighs about four pounds. An on-screen program monitors the PC's remaining battery life. The HP Vectra LS/12 comes standard with 1MB of RAM, a 1.44MB 3.5-inch diskette drive, and a nicad battery. Model 24 with a 20MB hard disk, $4,879; Model 44 with a 40MB hard disk, $5,479.
Hewlett-Packard Company, Customer Information Center, 19310 Pruneridge Avenue, Cupertino, CA 95014; 800/752-0900

CIRCLE 303 ON READER SERVICE CARD

The **Macintosh SE/30** from **Apple** operates four times faster than the Macintosh SE and provides users with DOS and OS/2 compatibility. The increased performance of the SE/30 is derived from the combined use of the Motorola 32-bit, 16-MHz 68030 and the Motorola 68882 math coprocessor.

Disk compatibility with DOS and OS/2 is accomplished by the SE/30's Apple floppy drive high density (FDHD), an internal 1.44MB diskette drive. The SE/30 comes standard with 1MB of RAM and the 1.44MB FDHD. Apple File Exchange, a utility available

Apple's Mac SE/30 with internal 1.44MB diskette drive

with Macintosh systems software, is used along with the FDHD to access and transfer files between DOS and ProDOS diskettes. The Macintosh SE/30 expansion-slot architecture supports advanced expansion options not previously available on a compact Macintosh, including video, memory parity, high-speed communications, and sound. Macintosh SE/30, $4,369; with a 40MB hard-disk drive, $4,869; with 4MB of RAM and an 80MB hard-disk drive, $6,569. Upgrades from the Mac SE were scheduled to be available in March; price not yet determined.
Apple Computer Inc., 20525 Mariani Avenue, Cupertino, CA 95014; 408/996-1010

CIRCLE 302 ON READER SERVICE CARD

Industry-standard PCs from **Digital Equipment Corporation** (DEC), based on Intel's 286 and 386 microprocessors, are fully DOS-compatible and designed to be peer members of a DEC networking environment (backed by DEC software and support services). The **DECstation 210**, based on a 10-MHz 286, comes standard with 640KB of RAM, a 1.44MB 3.5-inch diskette drive, VGA graphics, four 16-bit expansion slots, three 8-bit expansion slots, parallel and serial ports, a 40MB hard-disk drive, and either a 14-inch monochrome or color display.

The **DECstation 316**, based on a 16-MHz 386, comes standard with 1MB of RAM, a 1.44MB 3.5-inch diskette drive, VGA graphics, six 16-bit expansion slots and two 8-bit expansion slots, parallel and serial ports, a 40MB hard-disk drive, and either a 14-inch monochrome or color display.

The 20-MHz, 386-based **DECstation 320** comes standard with 2MB of RAM, a 1.44MB 3.5-inch diskette drive, VGA graphics, six 16-bit expansion slots, two 8-bit expansion slots, parallel and serial ports, an 80MB hard-disk drive, and a 14-inch monochrome or color display.

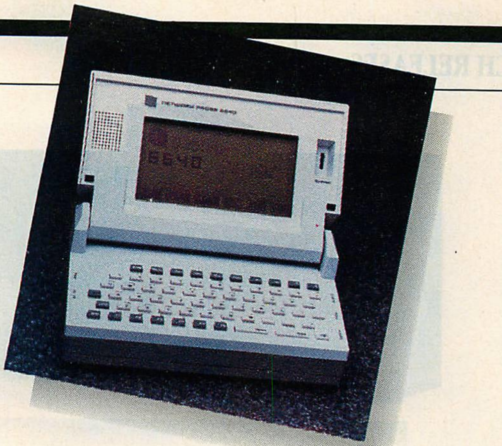
Available options for the three models include additional 3.5- and 5.25-inch diskette drives; 40MB, 80MB, and 170MB hard-disk drives; a 150MB cartridge tape drive; an Ethernet adapter; an internal modem; math coprocessor; and as much as 16MB of additional memory. DECstation 210, $2,630; DECstation 316, $3,485; DECstation 320, $4,960.
Digital Equipment Corporation, 146 Main Street, Maynard, MA 01754-2571; 800/344-4825; 508/493-5111

CIRCLE 301 ON READER SERVICE CARD

CONNECTIONS

FT/Express is a software product from **Digital Communications Associates** (DCA) for the high-speed transfer of information among IBM mainframes, PCs, and compatibles. FT/Express enables users of DCA's IRMA product to perform high-speed file transfers

Hewlett-Packard's HP Vectra LS/12, RS/20C, and RS/25C

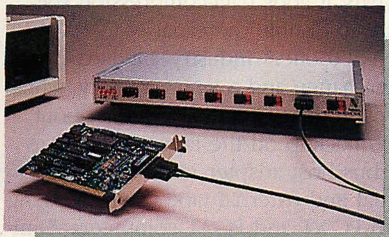


Network Communications' 6640 Network Probe

among local and remote PCs and mainframe computers. FT/Express supports VM/CMS and MVS/TSO operating systems. Through its host-to-PC report-transfer feature, FT/Express enables users to implement report-distribution applications. DCA is licensing either the CMS or TSO version of FT/Express for $9,000 per CPU plus a yearly maintenance charge of $1,800 per license. *Digital Communications Associates Inc., 1000 Alderman Drive, Alpharetta, GA 30201-4199; 800/241-4762; 404/442-4000*

CIRCLE 307 ON READER SERVICE CARD

A LAN that uses plastic optical fiber, **FIBERSTAR** from **Netronix** supports spans of 500 feet between two nodes (250 feet maximum from the hub). Because optical-fiber technology transmits computer data using pulses of light rather than electricity, it is immune to electrical interference. FIBERSTAR runs at 2 Mbps and interoperates with Ethernet, StarLAN, and

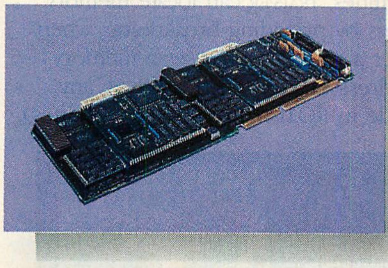


Netronix's FIBERSTAR uses plastic optical fiber

broadband networks using Netronix's line of media-independent bridges. The network includes a NETBIOS emulator and a Novell NetWare driver, as well as an optional transport control protocol/internet protocol (TCP/IP) communications package. Adapter boards with the TCP/IP package are priced between $595 and $895; 16-port hub, $2,195. *Netronix, 1372 N. McDowell Blvd., Petaluma, CA 94952; 707/762-2703*

CIRCLE 304 ON READER SERVICE CARD

Promoting multiprocessor slave-board technology and Novell connectivity, **Cubix** has introduced the **QL 2286** board, which features two AT-class machines on one AT bus-based add-in board. The two independent 286s on the board enable multiple users to share data, programs, disk storage, and



The QL 2286 multiprocessor board from Cubix

peripherals. A three-user network with two diskless workstations is created by installing one QL 2286 board in a network file server.

The QL 2286 runs in a Novell network environment under NetWare Entry-level System (ELS), Advanced NetWare 286, and System Fault Tolerant (SFT) NetWare. It works in conjunction with other existing topologies such as ARCnet and Ethernet. Each QL 2286 features 1MB of RAM per user (expandable to 2MB), a serial COM port for each user, and support for full EGA and CGA video output. An optional 287 is available for each user. $2,695. *Cubix Corporation, 2800 Lockheed Way, Carson City, NV 89706; 800/227-4139; 702/883-7611*

CIRCLE 305 ON READER SERVICE CARD

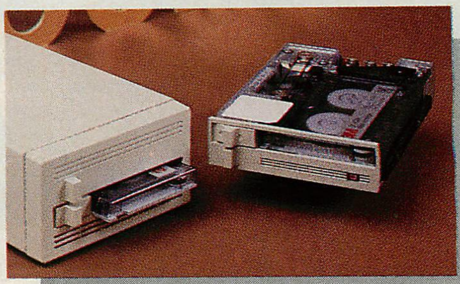
A portable network analyzer from **Network Communications** called the **6640 Network Probe** features 128KB of non-volatile RAM; monitoring, emulation, and analysis as fast as 256 Kbps; automatic configuration; remote control; VT-100 terminal emulator; graphic lead status; and a backlit liquid-crystal display (LCD). The **6640D Network Probe** comes with a built-in 3.5-inch diskette drive, adding 8,000KB of real-time mass storage with 50KB to 700KB data partitions. Both the 6640 and the 6640D include a parallel port; a serial port; a speaker monitor; and a special digital volt-ohmmeter with capture buffers, decibel-level measurements, and a variable threshold continuity tester with visual display. 6640 Network Probe, $5,995; 6640D Network Probe, $6,995. *Network Communications Corporation, 10120 W. 76th Street, Eden Prairie, MN 55344; 800/451-1984; 612/944-8559*

CIRCLE 308 ON READER SERVICE CARD

Novell has announced a set of tools that will decrease the effort required to develop distributed applications for NetWare and other networks. **NetWare Remote Procedure Call** (RPC), licensed by Novell for Netwise Inc., allows developers to create network protocol-independent applications that can be distributed across different hardware and operating-system environments. NetWare RPC will automate the migration of these applications to other protocols as support for them is added. The NetWare RPC tools automatically generate nonproprietary network code that complies with applicable standards of the International Standards Organization (ISO). The RPC network code can be created in several environments including DOS, OS/2, and DEC's VMS. The developer can easily port an application to other network protocols, which will be available from Novell and Netwise, such as NETBIOS, OS/2 named pipes, and transport control protocol/internet protocol (TCP/IP).

An RPC compiler supports programming-language extensions that allow a programmer to designate remotely executed procedures. The compiler automatically generates network-communications source code that facilitates the remote-procedure calls among the subroutines. It also generates code

Inspire erasable optical-storage system from Alphatronix



Colorado Memory Systems' QFA-500 500MB tape drive

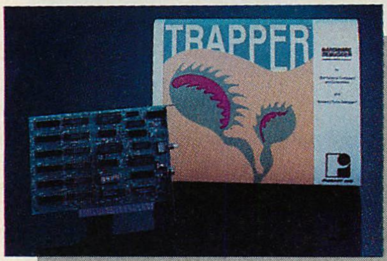
to convert data types among incompatible machine formats. The RPC network library provides a complete interface to the target interprocess-communications protocols. NetWare RPC for DOS (including compiler and library), $950; OS/2 version, $1,750.
Novell Inc., Development Products Division, 6034 W. Courtyard Drive, Suite 220, Austin, TX 78730; 512/346-8380
CIRCLE 306 ON READER SERVICE CARD

A new software product from **Alien Computing** allows users of Microsoft Windows to produce a fax file ready for transmission as easily as printing a document on a printer. **FAXit for Windows** consists of two parts—the FAXit Manager, which is a Windows application, and the FAXit Driver, which is a printer-device driver. The FAXit Manager takes the place of the Windows print spooler for fax purposes and adds fax-specific features. These include a personal database of fax numbers; the ability to group multiple fax numbers of frequently called groups, to view the list of faxes waiting for transmission as well as those received, and to convert a received fax file to TIFF or PCX format; and the capability to print the fax on any installed Windows printer.

When selected as the current printer, the FAXit Driver allows any Windows application to print to the installed PC-based fax hardware. Because the application prints directly to the FAXit device driver, which produces a fax file ready for transmission, the fax received at the destination is of a higher quality than normal fax transmissions. FAXit for Windows is available only to OEMs to be bundled with their products. Price is not available.
Alien Computing, 37919 50th Street East, Palmdale, CA 93550; 805/947-1310
CIRCLE 309 ON READER SERVICE CARD

PERIPHERALS

The TRAPPER debugger board from PURART extends and enhances the features of Borland International's Turbo Debugger by providing faster and more powerful memory and I/O breakpoint facilities. TRAPPER can locate memory bugs by providing breakpoints whenever a program accesses a memory address or range of addresses, any code in ROM (such as BIOS routines),



PURART's TRAPPER debugger board

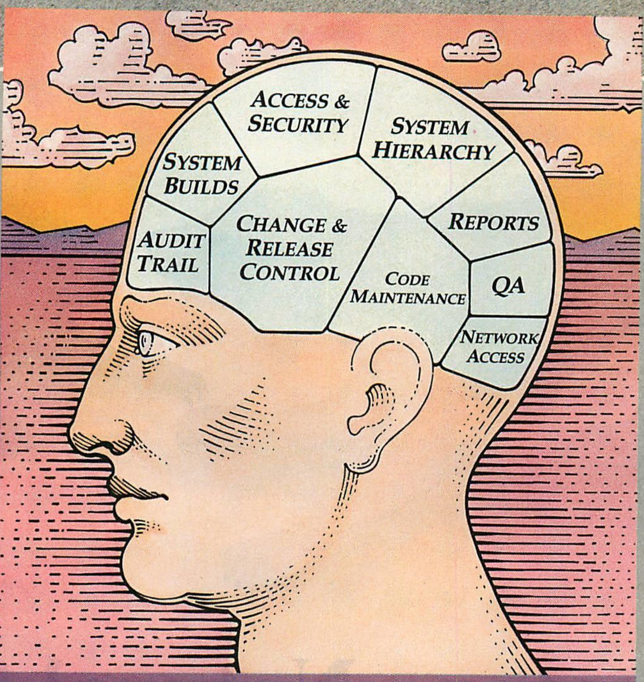
or an I/O port or range of ports. TRAPPER provides a breakout button allowing developers to get back into the debugger, even if a program has disabled interrupts. $199.95.
PURART Inc., 113 Drinkwater Road, P.O. Box 189, Hampton Falls, NH 03844; 603/772-9907
CIRCLE 314 ON READER SERVICE CARD

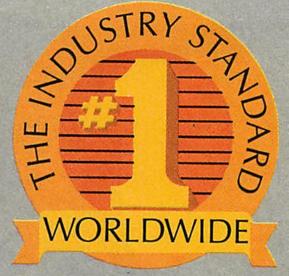
An erasable optical-storage system, designed specifically for Sun and DEC workstations as well as PC- and AT-bus computers has been developed by **Alphatronix**. The **Inspire** series is based on the international standards as defined by the American National Standards Institute (ANSI), European Computer Manufacturing Association (ECMA), International Standards Organization (ISO), and Japan Study Committee 23. Inspire for the PC is compatible with the PC and AT bus; it comes with all required connectors and software. Featuring complete support of DOS commands, Inspire provides a transparent interface. The Inspire series offers 650MB of user-available storage on a removable media cartridge. Single drive, $9,995; dual drive, $14,950.
Alphatronix, 4900 Prospectus Drive, Suite 1000, P.O. Box 13687, Research Triangle Park, NC 27709-3687; 919/544-0001
CIRCLE 313 ON READER SERVICE CARD

Jumbo+, a tape drive from **Colorado Memory Systems** with QIC-40 format, has a 120MB capacity. Based on the 40MB Jumbo tape drive, Jumbo+ adds 50-percent-longer tape length to the cartridge, extending its capacity to 60MB; with data-compression software, it is increased to 120MB. $399.

Also from Colorado Memory Systems, the **QFA-500** tape drive with QIC-150 format has a 500MB capacity. The drive adds a 67-percent-longer tape length to the cartridge, extending its basic capacity from 150MB to 250MB; it adds data-compression software to double the capacity to 500MB. QFA-500 offers industry-standard data interchange and a tape directory, which gives the user key information about each backup on the tape. A QIC-02-to-PC bus host adapter is required for internal and external tape drives working with PC/XT and PC/AT computers. Similarly, a QIC-02-to-PS/2 (Micro Channel) bus host adapter is required for internal and external tape drives working with PS/2s. Internal version, $1,395.00; external version, $1,795.00; QIC-02-to-PC bus adapter, $149.95; QIC-02-to-PS/2 adapter, $299.95.
Colorado Memory Systems Inc., 800 S. Taft Avenue, Loveland, CO 80537; 303/669-8000
CIRCLE 315 ON READER SERVICE CARD

A 300-dots-per-inch (dpi), six-page-per-minute (ppm) PostScript laser printer has been announced by **IBM**. The **IBM**





CONFIGURATION MANAGEMENT MADE SIMPLE

Automate the critical task of Configuration Management with easy to use and highly flexible tools from POLYTRON. You will discover why thousands of programmers and managers at the leading software, aerospace, manufacturing and service companies use the POLYTRON Version Control System (PVCS™) and PolyMake™ to control the revisions and versions of source code and automate the rebuilding process with unequalled power and precision. PVCS and PolyMake can be used independently or together.

"In terms of features, PVCS provides everything necessary to a large multi-programmer project — more than any other package reviewed ...all aspects of operation can be customized for specific project needs."

PC Tech Journal

Unmatched Capabilities

- Storage & Retrieval of Multiple Revisions of Source & Binary Code
- Maintenance of a Complete History of Changes
- Source Code Access Control
- Optional Merging of Simultaneous Changes
- Release and Configuration Control
- Project Activity Reports
- Management Reports
- Control of Separate Lines of Development (Branching)

For Simple & Complex Projects

Automatically rebuild and maintain simple or highly complex projects consisting of thousands of modules, multiple directories & disks, and geographically dispersed development locations.

Multiple Platform Development

If your projects are developed in a multiple operating system environment, or will be ported to run on another OS in the future, PVCS and PolyMake will make your job easier. The PVCS archive files (logfiles) and the command interfaces are exactly the same across operating systems. The same PolyMake makefiles can run unchanged on the different operating systems.

Supports ANY Language

PVCS maintains individual archives of all project components in your system — source code modules, data files, documentation and even object code. The "source documents" can be written in any language or multiple languages. PolyMake is also language independent.

Call About Our OEM/VAR Strategic Alliance Program

MS-DOS OS/2 Macintosh

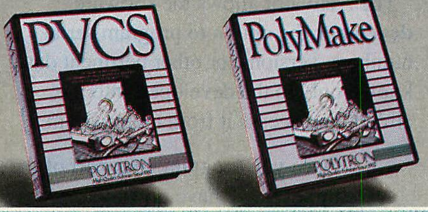
Fast Retrieval of Revisions

PVCS uses "reverse delta storage" which saves disk space and speeds retrieval of the latest versions of any module or an entire system. A delta is the set of differences between any revision and the previous revision. Differences are automatically detected and stored when programmers "check in" a file.

A Practical Necessity for LANs

While important for single-programmer projects, PVCS is absolutely essential for multiple-programmer projects and LAN-based development efforts. In a LAN environment, source code modules are simply too easy to change. Because any change to any module can have major ramifications, coordinating and keeping a record of changes is critical. Project leaders can determine on a module-by-module basis, which programmers can access or modify source files, libraries, object code or other files. Levels of security can be tailored to meet the needs of nearly every project. PVCS works on all major LANs and networks, including networks with multiple computer types.

The Leading Change Management System **The World's Best Selling Build Utility**



"PVCS has helped us maintain nearly 90 programs and utilities. Without it we would not have the quality of our new release of NetWare."

Jonathan Richey
Director of Product Development
Novell

Adopt PVCS & PolyMake On Existing Projects

You can obtain the benefits of configuration management for your current project without disrupting development, regardless of how long your project has been under way. You can build PVCS archives from revisions stored in your present archives or simply adopt PVCS from the current date.

PolyMake Works With PVCS

PolyMake understands the structure of PVCS logfiles and is able to correctly determine the time and date of any module revision. This prevents unnecessary operations that occur when the date and time of the revision archive file itself is used as with other Make utilities.

The Price AND Performance Leader

POLYTRON products are priced on a "Per User" basis. The price per user decreases as you add users. ■ ***MS-DOS, Macintosh MPW:*** **Personal PVCS** (for single programmer projects) $149 for single user. **Corporate PVCS** (has features for larger, more complex projects including unlimited levels of "branching") $395 for single user. **Network PVCS** (includes file locking and security features for LAN use) $1,284 for 5 users. **PolyMake** $149. **Network PolyMake** $484 for 5 users. ■ *PVCS and PolyMake are packaged together on OS/2, Sun UNIX and VAX/VMS.* ■ ***OS/2:*** $695 single user, $2,259 for 5 users. ■ ***Sun UNIX:*** $795 single user. $2,584 for 5 users. ■ ***VAX/VMS*** any model: $995 single user. $3,233 for 5 users. ■ Call for price quotes.

**OS/2 & Sun UNIX versions available late 1988.*

30 Day Money Back Guarantee

TO ORDER: 1-800-547-4000

Ask for Dept. PTJ. Send Checks and P.O.s To: POLYTRON Corporation, 1700 NW 167th Place, Beaverton, OR 97006. FAX (503) 645-4576, TELEX 325800 POLYTRON

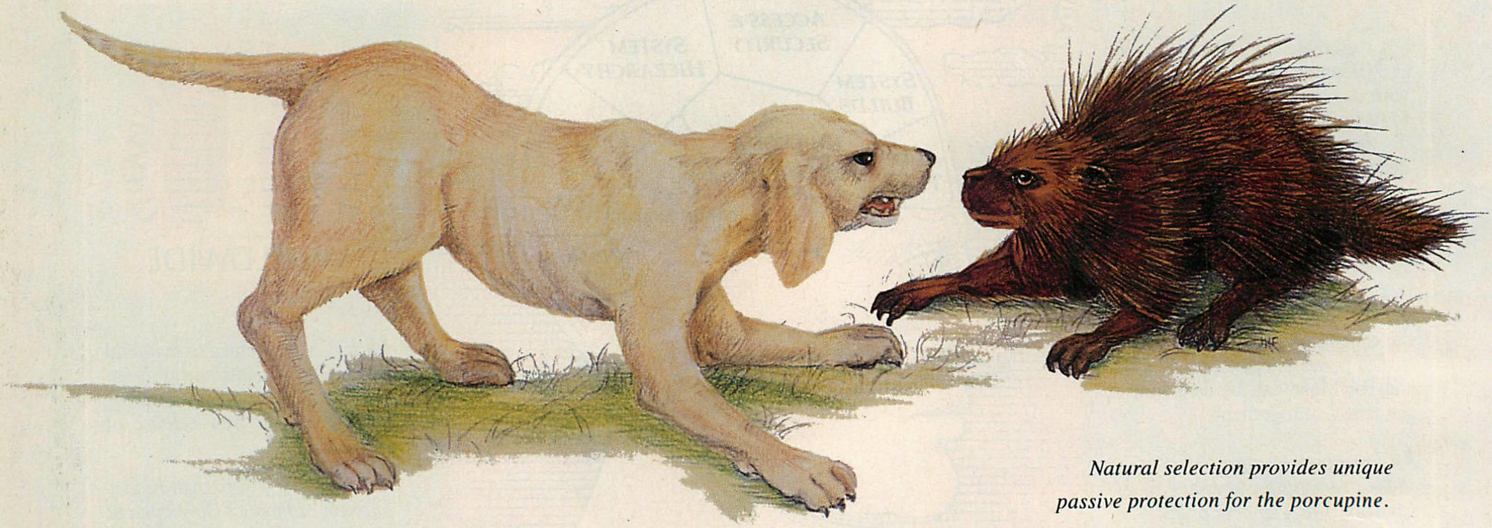
VAX/VMS Sun UNIX

POLYTRON®

High Quality Software Since 1982

CIRCLE NO. 144 ON READER SERVICE CARD

Software Developers



Natural selection provides unique passive protection for the porcupine.

The Activator - Natural Selection For Software Protection

Inventor and entrepreneur Dick Erett explains how "The Activator" provides sane protection for your intellectual property.

"In any industry, just as in nature, the process of natural selection raises one solution above another. Natural selection is the most elegant of engineers.

In the area of software protection The Block has been selected by the marketplace as the solution that works. Over 500,000 packages are protected by our device.

For the past 4 years our philosophy has been; *'You have the right and obligation to protect your intellectual property.'*

A New Ethic For Software Protection

In allowing end-users unlimited copies of a software package and uninhibited hard disk and LAN operation, The Block has created a new ethic for software protection.

By removing protection from the magnetic media we remove the constraints that have plagued legitimate users.

They simply attach our key to the parallel port and forget it. It is totally transparent, but the software will not run without it.

A New Technology For Software Protection

Our newest model, The Activator, builds on our current patented design, and establishes an unprecedented class of software protection.

We have migrated and enhanced the circuitry of The Block to an ASIC (Application-Specific Integrated Circuit) imbedded in The Activator.

This greatly improves speed and performance, while reducing overall size. Data protection can also be provided.

Programmable Option

The Activator allows the software **developer** the option to program serial numbers, versions, or other pertinent data known only to the developer, into the circuit, and access it from the program.

Once you program your part of the chip, even we have no way to access your information.

The ASIC makes emulation of the device virtually impossible. It also presents an astronomical number of access combinations.

Full 100% Disclosure

Since The Activator is protected by our patent we fully disclose how it works. Once you understand it, endless methods of protection become evident.

Just as no two snowflakes are the same, no two implementations of The Activator are identical. And like the snowflake the simplicity of The Activator is its greatest beauty.

We never cramp your programming style or ingenuity. Make it as simple or complicated as you desire.

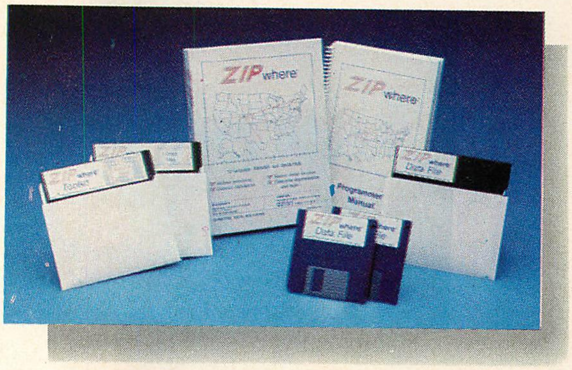
Let us help safeguard what's rightfully yours. Please call today for additional information or a demo unit. *It's only natural to protect your software.*"

1-800-333-0407 ext.102
In Connecticut 203-329-8870
Fax 203-329-7428

Software Security inc.
870 High Ridge Road
Stamford, CT 06905

Unlimited Copies • Programmable • No Batteries • Small Size • Fast • Patented • Data Protection

Compaq Advanced Graphics Color Monitor



Effective Data Solutions' ZIPwhere programmer's toolkit

Personal Page Printer II attaches to all models of the IBM PS/2, RT System, PC/AT, and PC/XT, as well as Apple workstations and networks using AppleTalk connectors. With 43 resident PostScript typeface styles that can be used in thousands of point sizes, the laser printer contains a controller board with a 16.67-MHz Motorola 68000 and 2MB of RAM. An optional 2MB memory expansion board is also available. A high-speed parallel driver is included that enables greater throughput when printing complex pages. The IBM Personal Page Printer II also emulates the IBM Proprinter XT and the Hewlett-Packard LaserJet Plus, enabling users to print documents created by non-PostScript-supported software, with letter-quality and Hewlett-Packard font support. Screen fonts for users of Microsoft Windows are included. $4,999.
IBM Corporation, product brochure, DRM, Department 122, 101 Paragon Drive, Montvale, NJ 07645; 800/426-7257, extension 122, for nearest dealer
CIRCLE 311 ON READER SERVICE CARD

For users who require higher screen resolution than VGA, the **Compaq Advanced Graphics 1024 Board** and the **Compaq Advanced Graphics Color Monitor** are available from **Compaq**. The graphics adapter features a 1,024-by-768-pixel resolution with 16 colors out of a palette of 16.7 million. The optional **Compaq Advanced Graphics Memory Board** provides 256 simultaneous on-screen colors at the same resolution for display of shaded three-dimensional renderings and images. The 1024 board uses a Texas Instruments 34010 graphics processor for faster screen updates and reduced wait time. A switchless configuration senses memory conflicts and reconfigures, avoiding conflicts with other peripheral boards. Support for 8- or 16-bit modes is included. Compaq Advanced Graphics 1024 Board, $1,499; Compaq Advanced Graphics Color Monitor, $1,999; optional Compaq Advanced Graphics Memory Board, $599.
Compaq Computer Corporation, 20555 FM 149, P.O. Box 692000, Houston, TX 77269-2000; 713/370-0670
CIRCLE 310 ON READER SERVICE CARD

A powerful disk-expansion unit from **S Tech** for the IBM PS/2 family is available. **POWERfile** contains an independent power supply and Micro Channel interface; it adds 4.5 inches to the system's overall footprint. POWERfile does not require the user to replace the installed hard-disk drive or sacrifice expansion capability; changes to the application programs or operating system are not necessary. For the PS/2 Models 25 and 30, versions of POWERfile are available with formatted disk capacities of 33MB, 46MB, and 84MB. For Models 50 and above, versions offering as much as 588MB per chassis are available. POWERfile can be expanded to a maximum of 2GB. Prices start at $995.
S Tech Corporation, 3216 Commander Drive, Suite 101, Carrollton, TX 75006; 800/336-0823; 214/250-1990
CIRCLE 312 ON READER SERVICE CARD

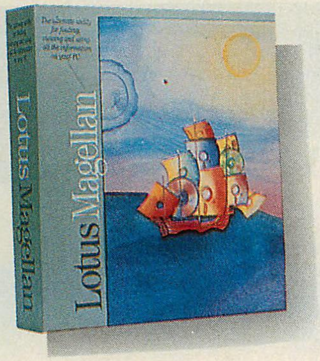
S Tech's POWERfile disk-expansion unit

The **Award POSTcard** is a plug-in diagnostics board from **Award Software** that monitors power-on self-test (POST) routines, provides continuous burn-in testing of preboot functions, and supports comprehensive system-component diagnostics for the IBM PC, PC/XT, PC/AT, and 386-compatibles. This diagnostics tool enables users to identify and analyze firmware problems, component failures, and manufacturing flaws for systems in any stage of development. The Award POSTcard does not require an operating system to support its functions; all of the POSTcard's functions operate prior to system boot. Trouble areas found by the POST routine are immediately defined and displayed for analysis on the POSTcard's port data LEDs. $399.
Award Software Inc., 130 Knowles Drive, Los Gatos, CA 95030; 408/370-7979
CIRCLE 317 ON READER SERVICE CARD

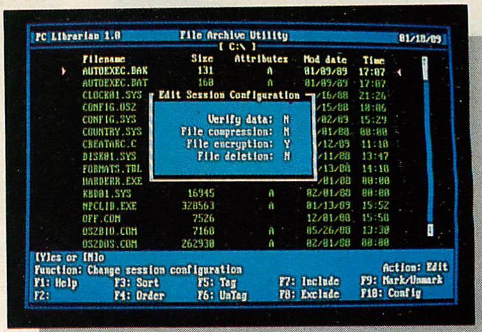
SOFTWARE DEVELOPMENT

A programmer's toolkit from **Effective Data Solutions** streamlines address processing and provides geographic intelligence to microcomputer business applications. **ZIPwhere**'s data files require less than 1MB of memory as a result of proprietary compression techniques. Designed for microcomputer programs written in C, ZIPwhere's database of more than 49,000 records contains ZIP codes and associated city names, states, counties, telephone area codes, time zones, latitudes and longitudes, and mileage grid coordinates. Library functions enable programs to retrieve the data sequentially or randomly, by ZIP code or city name. $139.
Effective Data Solutions, 28225 Agoura Road, Suite 102, Agoura Hills, CA 91301; 800/777-8818; 818/991-3282
CIRCLE 323 ON READER SERVICE CARD

A professional graphics series for high-resolution VGA users from **RIX SoftWorks** allows users to convert TARGA



Magellan hard-disk navigation utility from Lotus



United Software Security's PC Librarian

screen files into any RIX-supported EGA or VGA screens. **TRIX TARGA Translator Utility Pac** analyzes .TGA files and outputs VGA images. $499.

ScanRIX works with VGA, extended VGA, and the 8514A board to achieve precise scan control and clear images. The product does not require two monitors nor a TARGA board for operation. ScanRIX creates TARGA and ColoRIX files. $699.

Also from RIX, **PolaRIX** allows the user to use the Polaroid Palette Plus film recording device to create high-resolution EGA, VGA, and TARGA photographs and slides. PolaRIX creates film images with either 16, 32, or 64 levels (4,096, 32,000, or 260,000 colors, respectively) at resolutions of 640-by-350 or 640-by-700 pixels using the interlace option. A VGA board with an EGA outlet is required for 944-by-700-pixel film resolutions. $499.

RIX SoftWorks Inc., 18552 MacArthur Blvd., Suite 375; Irvine, CA 92715; 800/345-9059; 714/476-8266

CIRCLE 322 ON READER SERVICE CARD

A productivity tool for programmers of Nantucket Software's Clipper is available from **ArtFul Applications**. Features of **ARTFUL.LIB** include a report manager, a point-and-shoot query manager, a help manager, automatic data and index integrity, object-oriented validation routines for data entry, statistics capability, a window interface, pull-down menus with a menu builder, and print routines for the Hewlett-Packard LaserJet printer. $149.95.

ArtFul Applications, 2 Bloor Street West, Suite 100-512, Toronto, Ontario, Canada M4W 3E2; 416/538-3106 (collect calls accepted)

CIRCLE 325 ON READER SERVICE CARD

PC Librarian from **United Software Security** removes inactive files from the PC while retaining on the hard disk a catalog of information about the removed files. The user specifies which files are to be archived to an alternative medium, and to which medium these files will be archived. PC Librarian automatically archives and catalogs the selected files. The PC Librarian catalog, which remains on the hard-disk drive, provides the user with information about the archived files such as the contents of the files, where they reside, the date they were removed from the hard disk, and the size of the archived files. $99.

United Software Security Inc., 8133 Leesburg Pike, Vienna, VA 22182; 800/892-0007; 703/556-0007

CIRCLE 320 ON READER SERVICE CARD

Elographics offers a driver for touch-application development. **TouchBack** makes it possible to modify a program quickly so that it accepts touch input. TouchBack works with TouchUp, a program that allows a developer to take

Elographics' TouchBack driver for touch application

snapshots of any application screen and to define touch-zone boundaries by touching those boundaries on the CRT screen. Touch-screen hardware is available separately from Elographics. TouchBack can also capture and insert graphics screens into text-based applications. $99.

Elographics Inc., 105 Randolph Road, Oak Ridge, TN 37830; 615/482-4100

CIRCLE 326 ON READER SERVICE CARD

A hard-disk navigation utility from **Lotus** is now shipping. **Magellan** incorporates text-search technology to allow users to find desired information anywhere on their hard disks by specifying concepts or phrases. A viewing capability allows users to instantly inspect the contents of all files created in most common applications programs and in native file format. Once information has been located, Magellan can manipulate it by copying, moving, deleting, or printing files; by gathering portions of files from different applications into a single file; and by launching into another application from within Magellan. An efficient indexing technique occupies an average of 5 percent of the memory occupied by the files being indexed, making it possible to place an index of an entire hard disk on that same hard disk.

Programs supported by Magellan's file-format readers include Lotus 1-2-3 and Symphony, WordPerfect, Microsoft Word, and IBM DisplayWrite. The user can scroll through a word-processing, spreadsheet, or database file and see each one exactly as it would appear in its native application. Magellan requires an IBM PC or compatible, a hard-disk drive, 512KB of RAM, and DOS 2.1. $195; an introductory price of $139 is available until June 1989.

Lotus Development Corporation, 55 Cambridge Parkway, Cambridge, MA 02142; 617/577-8500

CIRCLE 318 ON READER SERVICE CARD

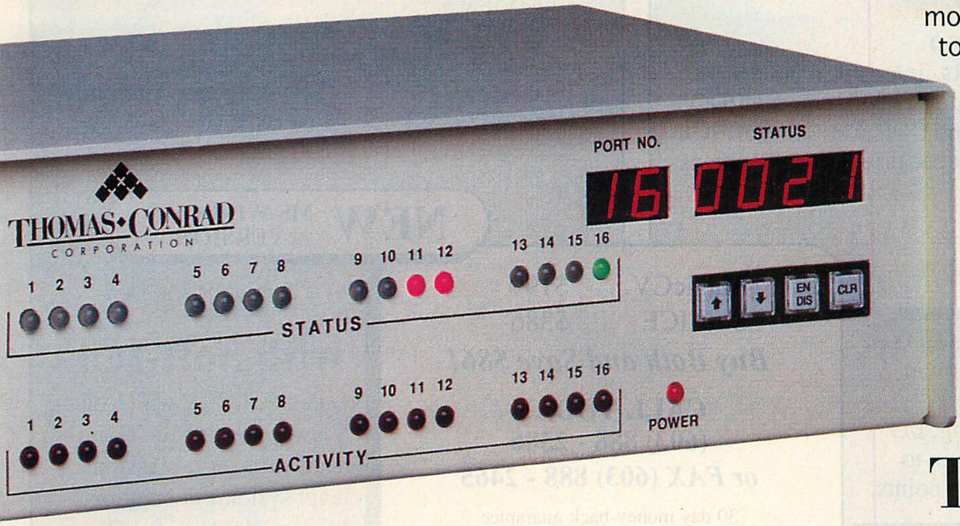
Application Developer's Kit for the Compaq Advanced Graphics 1024 Board (see Peripherals, p. 30) is available from **Graphic Software Systems** (GSS). The kit implements the Direct Graphics Interface Standard (DGIS) and includes DGIS firmware runtime code. DGIS has a base of hundreds of compatible software packages that includes major graphics environments such as computer graphics interface (CGI),

SOME COMPANIES MAKE ALL THE RIGHT CONNECTIONS.

FOR THOSE WHO DIDN'T . . . THERE'S THE SMART HUB.

The Smart Hub:

- Helps you find the problem . . . fast.
- Lets you disable a port at the touch of a button.
- Includes all the features of a Thomas-Conrad Active Hub.
- Works on *any* ARCNET LAN.



Even the best-maintained ARCNET® LANs sometimes develop a glitch. That's when it pays to have the Thomas-Conrad Smart Hub help locate problems on the network.

With a Smart Hub in place, you can detect the culprits immediately. Or you can monitor each port and get a readout that pinpoints where the trouble is. Then you can instantly disable the port and repair the problem . . . loose cables, bad boards, same node IDs, whatever. You can even move the Smart Hub to a different location to test out a separate set of workstations and interfaces.

The ARCNET Smart Hub is available in both 8 and 16 port versions for coax, twisted pair or fiber optic ports. Call Thomas-Conrad today and we'll show you how the Smart Hub sees to it that your problem ports are spoken to.

See us at
COMDEX/Spring '89
April 10–13, 1989
McCormick Place
Chicago, Illinois
Booth #214

THOMAS•CONRAD
CORPORATION

800-332-8683

8403 Cross Park Drive, Building One/C, Austin, Texas 78754 (512) 836-1935

ARCNET is a registered trademark of Datapoint Corporation.

SERIOUS DEBUGGING *at a* REASONABLE PRICE

All the speed and power of a hardware-assisted debugger at a software price

Hardware-level break points
REAL-TIME break points on memory locations, memory ranges, execution, I/O ports, hardware and software interrupts. More powerful break points than ANY software-only debugger on the market. Soft-ICE gives you the power of an in-circuit emulator on your desk.

Break out of hung programs
With a keystroke - no external switch necessary. Even with interrupts disabled.

Breaks the 640K barrier
Soft-ICE uses ZERO bytes of memory in the first 1MB of address space. This is especially useful for those subtle bugs that change when the starting address of your code changes. With Soft-ICE your code executes at the same address whether the debugger is loaded or not.

Works with your favorite debugger
Soft-ICE can be used as a stand-alone debugger or it can add its powerful break points to the software debugger you already use. You can continue to use your favorite debugger until you require Soft-ICE. Simply pop up the Soft-ICE window to set powerful real-time break points. When a break point is reached, your debugger will be activated.

Solve tough systems problems too
Soft-ICE is ideal for debugging TSRs, interrupt handlers, self booting programs, DOS loadable device drivers, non-DOS operating systems, and debugging within DOS & BIOS. Soft-ICE is also great for firmware development because Soft-ICE's break points work in ROM.

How Soft-ICE Works
Soft-ICE uses the power of the 80386 to surround your program in a virtual machine. This gives you complete control of the DOS environment, while Soft-ICE runs safely in protected mode. Soft-ICE uses 80386 protected mode features, such as paging, I/O privilege level, and break point registers, to provide real-time hardware-level break points.

"Soft-ICE is a product any MS-DOS developer serious enough to own a 386 machine should have."
Dr. Dobb's Journal — May 1988

Both require 80386 AT compatible or IBM PS/2 Model 80. MagicCV requires at least 384K of extended memory. CodeView is a trademark of Microsoft Corporation.

RUN CODEVIEW IN ONLY 8K!

CodeView is a great integrated debugger, but it uses over 200K of conventional memory. MagicCV uses advanced features of the 80386 microprocessor to load CodeView and symbols in extended memory. This allows MagicCV to run CodeView using less than 8K of conventional memory on your 80386 PC.

Don't let 640K be your limit!
If you are closing in on the 640K limit and would like the power of CodeView, MagicCV is for you.

Don't let the debugger hide the bug!
Even if you're not closing in on the 640K limit, running CodeView with MagicCV makes your debugging environment much closer to the end user's program environment. You can use CodeView to locate subtle bugs that only occur when there is plenty of free memory, or those difficult bugs that only occur when your program is running with a couple of TSRs loaded.

How MagicCV works
MagicCV uses the 80386 to create a separate virtual machine for CodeView. MagicCV uses between 4K & 8K of conventional memory as a bridge between the DOS environment and CodeView.

MagicCV is easy to use
If you are a CodeView user, you already know how to use MagicCV too. Just type MCV instead of CV; everything else is automatic.

NEW MS-WINDOWS VERSION

MagicCV with Soft-ICE

Using Soft-ICE with CodeView gives you the features necessary for professional level systems debugging. MagicCV and Soft-ICE can work in concert with CodeView to provide the most powerful debugging platform you will find anywhere.

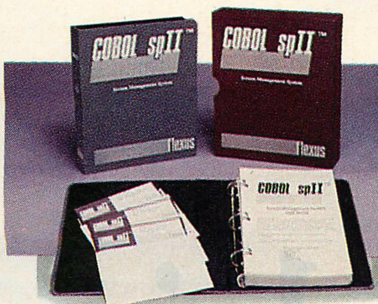
MagicCV	$199
Soft-ICE	$386

Buy Both and Save $86!

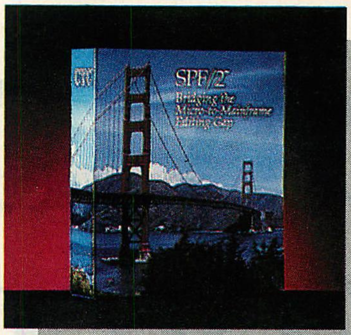
CALL TODAY
(603) 888 - 2386
***or FAX* (603) 888 - 2465**

30 day money-back guarantee
Visa, Master Card and AmEx accepted

NU-MEGA TECHNOLOGIES
P.O. BOX 7607 • NASHUA, NH 03060-7607



COBOL spII 1.2 development tool from Flexus International



Command Technology's SPF/2 text-editing program

graphics kernel system (GKS), X Window System, Microsoft Windows, and Digital Research's GEM. $195.
Graphic Software Systems Inc., 9590 S.W. Gemini Drive, Beaverton, OR 97005; 503/641-2200
CIRCLE 319 ON READER SERVICE CARD

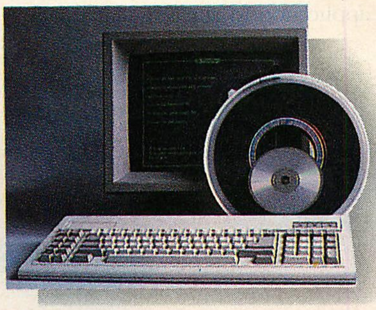
Flexus International Corporation has announced **COBOL spII**, a development tool that supports prototyping and user-interface management for PC COBOL applications. **Version 1.2** includes scrollable fields on data-entry screens with complete field validation processing capability. Many of the screen display capabilities, such as horizontally and vertically scrollable fields, are those required by IBM's Systems Application Architecture (SAA) common-user-access (CUA) standards. Interactive models built by COBOL spII can be easily converted into a COBOL program. Characteristics that may be incorporated into a prototype include menu screens, data-entry screens, field-sensitive help screens, panel-sensitive help screens, and scrolling text-entry or menu panels. $395.
Flexus International Corporation, P.O. Box 9119, Morristown, NJ 07963-9119; 201/895-4724
CIRCLE 324 ON READER SERVICE CARD

Three members of **Command Technology Corporation**'s (CTC) family of text-editing and procedural-language programs for OS/2 are available. **SPF/2** complements CTC's SPF/PC text editor and GML/PC as an OS/2 implementation of IBM's MVS editor. $245.

Also from CTC is **REXX/2**, which fully implements the IBM Systems Application Architecture (SAA) REXX mainframe procedural language. The PC-based REXX/2 software can be used as an enhanced command language or general-programming language. It is also suitable for providing macro capabilities for other CTC products. The product will interface with several optional environments, including VM/CMS EXECIO emulation, OS/2 command level, OS/2 system level, and user programs. $195.

XEDIT/2 is an OS/2 implementation of the IBM VM/CMS System Product Editor, XEDIT. The product features the same interface and capabilities as its mainframe counterpart and is compatible with REXX/2. $245.
Command Technology Corporation, 1900 Mountain Boulevard, Oakland, CA 94611-2813; 800/336-3320; 415/339-3530
CIRCLE 321 ON READER SERVICE CARD

Crowninshield Software has released **MediaBase CD-ROM Formatter**, a utility that creates International Standards Organization (ISO) 9660-volume image files, enables users to generate in-house a logical image on an ISO volume (including the necessary directories, path tables, and volume descrip-



Crowninshield Software's MediaBase CD-ROM Formatter

tor data, as well as all files in the DOS directory and subdirectories). The image file output of the program is suitable for nine-track tape, or other media, which can then be sent to a CD production facility for duplication. When used in conjunction with MediaBase, Crowninshield's multimedia database, the utilities are designed for optimal information-retrieval times from published CD-ROMs. The publishing utilities run on a PC/AT or 386 with a large hard disk and an attached nine-track tape. $1,995.
Crowninshield Software Inc., 1105 Commonwealth Avenue, Boston, MA 02215; 617/787-8830
CIRCLE 327 ON READER SERVICE CARD

DATABASE MANAGEMENT

An enhanced version of **Professional ORACLE** from **Oracle** includes application tools and utilities that run in either real or protected mode above the 640KB memory line. **Version 5.1B** includes SQL*Report Writer, a menu-driven report generator that creates single- and multiple-query reports in many formats including tabular, form letter, labels, crosstabs, and financial reports. $1,299.
Oracle Corporation, 20 Davis Drive, Belmont, CA 94002; 800/672-2531; 415/598-8000
CIRCLE 329 ON READER SERVICE CARD

An on-line transaction processing (OLTP) implementation of INGRES Release 6.0 from **Relational Technology** features pop-up windows, an improved INGRES menu, and screen-painting tools. Building on the multiserver architecture of the earlier release, **INGRES Release 6.1** offers OLTP capabilities and scalable performance in multiprocessor environments. Developers can take advantage of the capabilities without rewriting existing applications. Prices range from $5,000 to $180,000, depending upon machine class.
Relational Technology, 1080 Marina Village Parkway, Alameda, CA 94501; 800/446-4737; 415/769-1400
CIRCLE 330 ON READER SERVICE CARD

The material that appears in Tech Releases is based on vendor-supplied information. These products have not been reviewed by the PC Tech Journal *editorial staff.*

Leaving 640KB Behind

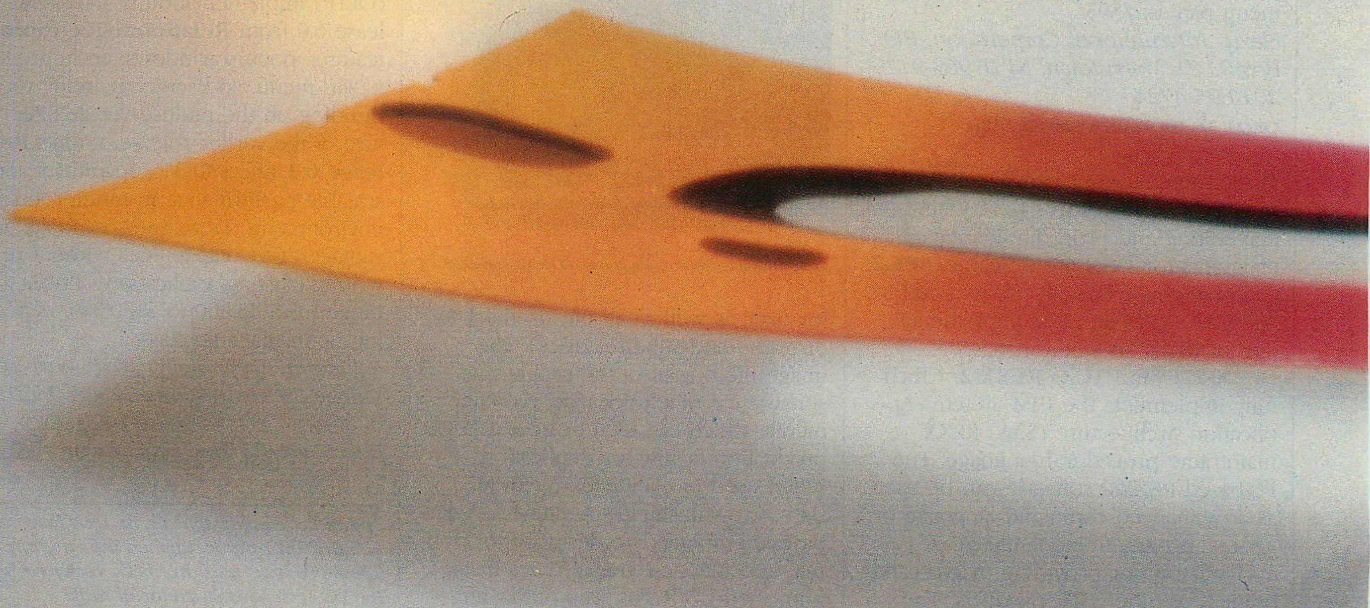
Although rumors of the demise of DOS are premature, this venerable operating system cannot keep up with high-end desktop computer systems. An adequate return on investment in sophisticated microcomputer hardware requires going beyond DOS's 640KB memory barrier and its inability to run more than one program at a time. Migration to a new operating system, such as OS/2 or Unix, is one possibility, but this requires a commitment in time and money from applications developers and users.

The alternative to replacing DOS is to stretch it beyond its standard limits. For this, DOS extenders take center stage. A DOS extender is a tool for creating and executing programs for 80286- and 80386-based systems. Its kernel starts under DOS, switches the processor into protected mode to take advantage of 16MB of extended memory, loads an application into extended memory, and provides an interface between the application and DOS operating-system services such as I/O.

DOS extenders currently available are OS/286, OS/386, and OS/386-HB (collectively called OS/x86) from A. I. Architects Inc., 386/DOS-Extender from Phar Lap Software Inc., and DOS/16M from Rational Systems Inc. Phar Lap's 386/DOS-Extender is for 386 systems only, DOS/16M is for both 286 and 386 systems, and A. I. Architects has a version for each processor.

DOS-windowing environments also stretch DOS by allowing more than one application to run simultaneously. A second article in the cover suite ("Drawing Out DESQview Power," Frederick J. Hitt, p. 46) describes how the application program interface (API) to Quarterdeck's DESQview (a windowing environment that can multitask DOS programs) optimizes performance of each DOS application.

More than 100 applications currently use DOS extenders; table 1 gives a representative sampling. Many vertical-market applications, such as Wall Street Analytics Inc.'s PC-based security analysis package, the Structured Financing Workstation, exist in DOS-extender environments (see the sidebar "Beyond DOS . . . into a Black Hole?"). In addition, many mainframe and minicomputer applications whose scope in both data and code space is too great to



Rather than move to a new operating system, many developers would rather help their DOS programs to reach more memory. Although they do not bring enhanced interfaces or multitasking, DOS extenders do let programs tap up to 16MB of memory.

WILLIAM BROOKS

port to plain DOS have been ported using a DOS extender.

Unlike an extended-memory RAM disk, a DOS extender does more in protected mode than transfer data between conventional and extended memory. When using a DOS extender, an application executes in protected mode; both code and data can reside in extended memory, obviating the need for code overlays, data swapping, and other memory-conservation techniques that reduce performance.

The developer gains hardware-implemented checking of all addresses to prevent writing outside the program's data space or executing outside its code space. These tools also make it easy to debug applications. Whether applications are developed in or ported from DOS real mode, testing in protected mode can catch bugs undetected in real mode.

An extender can move terminate-and-stay-resident (TSR) utilities out of DOS memory into extended memory, while making them available to real-mode DOS programs. At installation, the TSR executes in real mode, switches to protected mode, loads its code into extended memory, returns to real mode, and exits to DOS after leaving a small stub resident in conventional memory. When a hot key or software interrupt activates the TSR, the stub switches to protected mode and branches to main code in extended memory.

Extender kernels also provide functions for switching be-

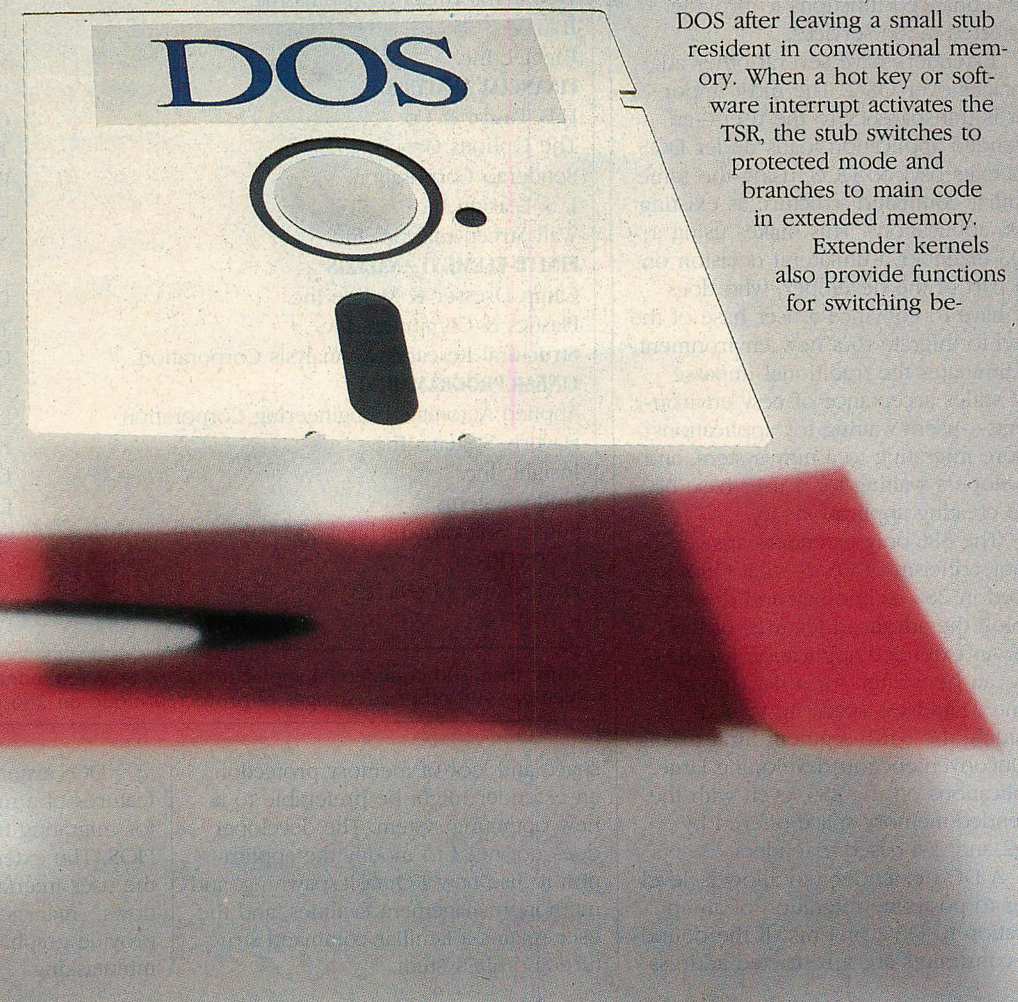


ILLUSTRATION • STUDIO 65

tween real and protected modes under program control, and for issuing intermodal procedure calls. This allows an application built using a DOS extender—an *extended application*—to use real-mode function libraries or other code that cannot be ported to protected mode because the source is not available. This is not possible under OS/2.

DOS extenders do, however, share important characteristics with OS/2—they require at least a 286 processor (some require a 386) and they need a good deal of memory, depending on the application.

RATHER FIGHT THAN SWITCH

Because the underlying operating system is DOS, creating an extended application or porting one from plain DOS is easier than doing the same for a new operating system such as OS/2. Each DOS extender provides porting tools that automate the conversion of simple applications. The application program interface (API) to the extender kernel is more familiar to the DOS developer than the OS/2 API. For example, the Phar Lap DOS Extender has the same INT 21H API as DOS, but with enhanced functions to provide protected-mode services.

Extenders have several other advantages over OS/2. The most important is transparency to the user—an extended application loads under DOS and exits back to DOS, using the same familiar command structure as existing DOS applications. This makes using a DOS extender a unilateral decision on the part of the developer, who does not have to convince a user base of the need to migrate to a new environment. It eliminates the traditional impasse that stifles acceptance of new environments—users waiting for applications before migrating to a new system, and developers waiting for a user base before creating applications.

The 386-only extenders answer a major criticism of OS/2—that OS/2 is mired in 286 technology and does not exploit the advanced features of the 386. An extended application for the 386 can be written for a flat (unsegmented) address space up to 4GB, avoiding the 64KB-segment limit that is an inconvenience in developing large applications on the 286, even with the extended-memory space offered by OS/2 and 286-based extenders.

A DOS extender can allow a developer to postpone migration of an application to OS/2 or Unix. If the boundary constraints are a restricted address space and lack of memory protection, an extender might be preferable to a new operating system. The developer does not need to modify the application to use new I/O, task-spawning, and memory-management facilities, and the user retains a familiar command structure and file system.

DOS extenders do not provide all features of a modern operating system for migrating from the constraints of DOS. The extenders do not enhance the user interface: they do not "do windows," manage menus or dialog boxes, provide graphics output, or support multitasking.

TABLE 1: *Representative Applications with DOS Extenders*

COMPANY	PRODUCTS
COMPUTER-AIDED DESIGN/ENGINEERING	
Applied Optics Research	GLAD
Autodesk Inc.	AutoCAD
Bartels System Gmbh	Bartels Autorouter
CAD Software Inc.	PADS-SuperRouter
The Cadds Man Ltd.	CADDSMAN series
Cadkey Inc.	Cadkey 3.0 Plus
CADUL Gmbh	CAD-UL
Custom Arrays Corporation	Liberty
Data I/O-FutureNet	DASH-GATES-386
Hewlett Packard	ME10/DOS
Hochtief AG	UNICAD/386
Integrated Silicon Systems Inc.	LTL-100
Manufacturing & Consulting Services	ANVIL-5000pc
Point Control Company	SmartCAM
Viewlogic Systems Inc.	Viewsim, Workview
DATA MANAGERS	
Borland International	Paradox 386
Fox Software	FoxBASE+/386
Informix Software Inc.	Informix series
Oracle Corporation	Professional ORACLE
Symantec	Q&A
Thorn EMI Software	Time Intelligence
DESKTOP PUBLISHING	
Command Technology Corporation	GML/PC 3.0
Dewar Information Systems Inc.	DISC/series
IBM	Interleaf Publisher
Pagetec Inc.	Versacomp
FINANCIAL ANALYSIS	
H.B. Pascal & Co.	Center, Office/2
The Options Group	TOG++
Senderao Corporation	Plan 80
U.S. Leasing Inc.	Leasing Analysis Program
Wall Street Analytics Inc.	SFW
FINITE-ELEMENT ANALYSIS	
Camp Dresser & McKee Inc.	Dynaflow
Plastics & Computers Inc.	TM-Concept
Structural Research & Analysis Corporation	COSMOS-M/386
LINEAR PROGRAMMING	
Applied Automated Engineering Corporation	LPS-867
Haverly Systems Inc.	HS/LP, Omni
Insight, Inc.	GNET, GENNET, EMNET
Lindo Systems	Lindo/386
Sunset Software Technology	XA-386
STATISTICS	
Dubin Rivers Research	SST
P-STAT Inc.	PSTAT-386

More than 100 commercial applications use DOS extenders to gain the extended memory and other advantages of protected mode on 286 and 386 systems.

Providing an enhanced user interface and multitasking is the province, not of a DOS extender, but of a windowing environment such as DESQview or Microsoft Windows, but these systems are designed for programs that fit within the DOS memory space. All DOS extenders permit running one extended application within DESQview or Windows 286, along with DOS programs in conventional memory. The 386-specific extenders build applications that can multitask with compatible, extended applications under DESQview.

TERMS OF AGREEMENT

DOS extenders that run a single application in protected mode are one of three kinds of control programs that use the capabilities of the 386 chip under DOS. The other two are multitasking environments such as DESQview and Windows that run several DOS applications at once, and expanded memory specification (EMS) emulators such as Qualitas's 386-to-the-Max and Quarterdeck's QEMM-386 that use the chip's paging capability to map extended memory into EMS page frames. Multitaskers and EMS emulators create a DOS environment in virtual-8086 (V86) mode.

The protection hardware of the 386 mandates that processes running in V86 mode run at privilege level 3, the

BEYOND DOS . . . INTO A BLACK HOLE?

When systems integrators set their sights beyond the outer limits of DOS, even the most intrepid voyagers fear being sucked into a black hole of development problems.

One of the biggest advantages of a DOS extender is that risk of the unknown is almost nil. Wall Street Analytics Inc. discovered this when using the 386/DOS-Extender from Phar Lap to develop the Structured Financing Workstation (SFW), a PC-based mortgage security analysis package. While they offer more functionality than DOS, the development environments of DOS extenders are virtually identical to plain DOS, posing no hybrid difficulties.

Wall Street Analytics was faced with this dilemma: their planned financial system would power up securities analysis on their clients' PCs (80386-based machines exclusively with 80387 math coprocessors), but DOS's 640KB memory limit and 64KB segment sizes were standing in the way. As with a growing number of applications today, DOS did not provide enough memory for the system to perform the required number crunching and analysis. An improved operating environment was needed to keep up with the hardware capabilities of the 386 systems.

Once they realized that DOS alone could not accommodate SFW, Wall Street Analytics's President Ron Unz and his partner Tim Rand considered several alternatives before settling on an extender. OS/2 was rejected for two reasons. First, its segmented address space, although virtually transparent to the C programmer, would limit performance. Because SFW competes with mainframe systems, performance is a prime consideration. The second reason was the unfamiliarity of the environment and the development tools available within it.

Unix was rejected because it would require convincing potential users, the majority of whom use DOS, to switch to a new, unfamiliar operating system. An extender, on the other hand, removes the memory limitation of DOS while letting both the developer and end user work in the same familiar environment with the same familiar tools and methods.

"We weren't experts in DOS extenders," says Unz, characterizing the process he and Rand pursued. The Phar Lap product won out because it was one of the first available and several compilers on the market could run under it.

Initially, development began in Borland's Turbo C, but as the program grew, it soon outstripped the DOS-imposed limits of that compiler. Building the application under Phar Lap's 386/DOS-Extender required converting to one of the 32-bit compilers. Unz and Rand chose MetaWare's 80386 High C Compiler because it was the most ANSI-compatible. However, they were loath to give up the amenities of Turbo C's integrated development environment, such as the interface between the Make facility and the editor that automatically loads whichever modules generate compilation errors. So, instead of converting totally from Turbo C to High C, they converted to a form acceptable to both compilers.

The conversion involved two steps. The first was to resolve differences between Turbo C and High C in the operations of specific functions. For example, the **memcpy** function automatically handles overlapping blocks in Turbo C, but not in High C, requiring the addition of code for special handling of overlaps. The second step was to write a small library of low-level functions such as **peek** and **poke** that Turbo C provides but High C does not.

"Apart from writing low-level functions, the initial effort for the conversion took about a day," says Unz. "After that, we found that by taking care to use functions common to both compilers, we could get by with a single version of the source code."

Even after SFW grew to more than 160,000 lines of code and required several megabytes to execute, Turbo C was still being used for development and initial testing of enhancements and additions. Because of the modular nature of the program, new features can be built and tested with a subset small enough to compile with Turbo C and run under DOS in real mode. Once fully operational in this mode, the additions are incorporated into the full product for final testing.

Wall Street Analytics created their own user interface instead of incorporating a commercial interface library. "We bought three window libraries but found them too general," says Unz. "They provide many more capabilities than we want, but not the specific ones we need."

Instead, SFW incorporates its own windowing package written in the Turbo C graphics library. The intermode calling capabilities of 386/DOS-Extender allows using these easily from protected mode.

With development of the package now complete, SFW is being sold to issuers and buyers of million-dollar securities. Reflecting on his venture into the world of DOS extenders in order to produce the package, Unz concludes: "The DOS-extender environment gave us everything we needed to develop our large application without the overhead, bugs, and potential incompatibilities of going to an entirely new operating system. It turned out to be the best way to get the program up and running."

—Ted Mirecki and Jordene Zeimetz

lowest, where they are not allowed to perform system-level activities, such as switching into protected mode. (For a full description of protected-mode privilege levels, see the sidebar, "How Protected Mode Protects," Ted Mirecki, November 1987, p. 80.) This means that a stand-alone DOS extender cannot start from V86 mode; the user must reboot the system without the V86 control program to enable the protected-mode extender kernel to start up in real mode.

Quarterdeck and Phar Lap developed and published a method by which an extended application can start from V86 mode. Known as the Virtual Control Program Interface (VCPI), it defines a protocol by which a level-3 program can determine the presence of a V86 control program and request it to perform protected-mode services, such as allocation of extended memory and execution of protected-mode processes. This protocol is not intended for use by application developers, but by system programmers who need to implement communications among multiple control programs at higher privilege levels.

In addition to eliminating a special boot for running extended applications, VCPI allows a multitasking environment to run more than one extended application at a time. DESQview and all of the DOS extenders reviewed in this article (for both 286 and 386 systems) support VCPI but Microsoft Windows/386 does not.

Another compatibility issue for DOS extenders is coexistence with RAM disks such as DOS's VDISK that use extended memory in protected mode. DOS extenders automatically sense which memory is in use. However, not all programs using extended memory inform DOS of the memory they have appropriated. Most of the DOS extenders have command-line switches that delimit the range of available extended memory.

To switch between real and protected modes, DOS extenders rely on a hardware configuration conforming to the current IBM PC/AT and PS/2 standards. This configuration must allow resetting the 286 processor by writing to a port in the keyboard controller, and gating on and off the processor's A20 address line to toggle access to memory above 1MB. Non-IBM machines may have the hardware and BIOS support to perform these functions. Each DOS-extender vendor provides information about supported and unsupported hardware platforms.

Products limited to 386-based systems (OS/386 and 386/DOS-Extender) gain a performance edge from CPU features—a nonsegmented address space and improved mode-switching capabilities. On the 386, switching modes requires merely writing a bit to a control register. However, an application gains this advantage at a price; the market for a 386-only product is smaller than for a 286/386 product.

On a 286 system, switching to protected mode is just as easy, but switching back to real mode requires a full reset of the processor. Before resetting, the control program must save in the BIOS data area the location of the code following the reset call, and place a special shutdown code in the complementary metal-oxide semiconductor (CMOS) memory. Activating the reset line clears the processor, puts it into real mode, and forces a jump to the power-on procedure in ROM. If the procedure in the CMOS finds the shutdown code, it branches to the address saved in the BIOS data area; otherwise, execution falls into the power-on diagnostics. This procedure can take from several hundred microseconds to more than a millisecond. Because the operating system ignores hardware interrupts, any communications programs running concurrently in a multitasking scenario can lose data.

DOS extenders maintain selector tables, respond to protection faults, and transfer data between protected and real modes.

A final compatibility issue is how easily, if at all, an existing DOS application can be ported to an extender. A. I. Architects and Rational Systems provide tools to convert a DOS-executable file automatically to a protected-mode executable. Applications most successfully ported include those coded in a high-level language, such as FORTRAN and C, that meet all of the Microsoft recommendations for a "well-behaved DOS application."

UNDERCOVER WORK

DOS extenders are small-scale system kernels that run on, under, and in concert with DOS. They switch between real and protected modes to meet application needs and to handle the application's interface to DOS and BIOS services, processor exceptions, and software and hardware interrupts. In protected mode, they provide access to the extended memory (above 1MB) of the hardware platform and handle CPU initialization and operation. Protected mode provides virtual-segmentation features that access the extended-address range and validate memory references to prevent unauthorized access, such as writing or executing outside a process's data-code space.

In real mode, each segment register points directly to the physical location of a segment in memory. The hardware generates a 20-bit linear memory address by shifting the 16-bit segment address left by 4 bits and adding the 16-bit offset value.

In protected mode, segment registers contain selectors (indexes) that point to entries in global or local descriptor tables (GDTs or LDTs). Each descriptor contains a set of parameters defining a segment, including its base address and length, contents (code or data), privilege level of code allowed to access it, and access type (read-only, read-write, or execute-only). A linear memory address is generated by obtaining the descriptor that the selector points to, then adding the offset value to the base address.

On the 286, the base address is 24 bits long (corresponding to a real address space of 16MB) and the offset is 16 bits, limiting the segment size to a maximum of 64KB. On the 386, the base and offset are 32 bits each. If the entire address space of a 386 is defined as one segment, the space can appear as a flat expanse of memory.

Once it generates the linear address, the CPU checks that the requested access is within the length and type specified in the descriptor. If not, it issues an exception interrupt that is handled by an exception handler in the protected-mode extender kernel.

The memory architecture of the 386 adds virtual paging to the 286's segmentation features. Virtual paging operates below the segmentation level, imposing a second level of translation from linear 32-bit addresses to physical locations in memory. Paging allows the mapping of physical memory to anywhere in the address space; it supports bank-switching schemes, such as expanded memory and multiple V86 machines, each of which provides an environment with virtual-memory addresses of 0 to 1MB.

A DOS extender establishes and maintains selector tables, responds to protection faults whenever limits are broached, and handles transfers between protected and real modes. When a protected-mode task needs the services of a real-mode task (such as a DOS function call or a real-mode interrupt handler), the extender kernel takes care of all mode-transition memory overhead.

All extenders work with DOS to provide a complete environment for the application. They support DOS services by emulation within the kernel in protected mode or by switching to real mode to execute the original DOS code. An application that relies on DOS or BIOS for support receives the same level of support when ported for use with an extender.

API services include functions to migrate between real mode and protected mode on program request, to allocate memory in the extended or conventional ranges, and to implement message and data transfer between real- and protected-mode procedures. The extenders need not provide extensive API support because they are compatible with DOS in such areas as file-system I/O support and timer services. High-level language programs that do not require dual-mode operation do not require these API services. Instead, they rely on protected-mode versions of standard library functions supplied by the extender vendor in a special library. These modified link-time libraries provide transparent access to features of each kernel's API.

By creating applications that operate without extended memory, making do with conventional memory is possible with DOS extenders. The application runs on any kind of system, reverting to a mode of reduced functionality as an alternative to failing for lack of extended memory.

Extenders provide various access techniques to the I/O facilities of the hardware platform. A program can use the BIOS and DOS video services or can access video memory. Protected mode requires indirect addressing through the selector tables; each extender creates special LDT or GDT selectors defining the video-memory area and other BIOS-related memory ranges, such as the data area at segment 40H. In addition, each extender allows direct I/O operations to the hardware ports in protected mode.

For numeric processing, DOS/16M supports the Intel 80287 and 80387 coprocessors, and OS/*x*86 and 386/DOS-Extender support the Weitek 1167 and Intel coprocessors. The support includes switching the coprocessor to protected mode with the main CPU and routing coprocessor interrupts to protected- or real-mode interrupt handlers provided by compiler libraries.

EXTENDING YOUR APPLICATIONS

A DOS-extender development kit comes with the runtime kernel to the extended application and provides protected-mode system services, a utility for binding the loader into the application for distribution as a self-loading file, a protected-mode debugger, replacement link-time libraries, and .EXE conversion utilities. Table 2 lists components of each vendor's product.

Applications ported to DOS extenders can retain standard DOS and BIOS services for system-file I/O and memory management.

Tools and procedures for building an extended application depend on whether the extender supports both the 286 and 386 systems or only one. For 286-based extenders, a developer can build the application using any standard compiler for which protected-mode libraries are available from either the compiler vendor or the extender vendor. After linking with a DOS linker, the developer must convert the executable file to protected-mode form using a utility provided with the extender.

The 386-based extenders require 32-bit versions of compilers and linkers, but the resulting executable file can run in protected mode without post processing. Table 3 lists compatible compilers and linkers that work with each DOS extender.

Porting an existing application to a DOS extender can be simple or difficult, depending on how well-behaved a DOS task the application is. The .EXE conversion utilities from A. I. Architects and Rational Systems can transform a simple DOS executable file into an extended application; or a DOS application may require a simple relink with protected-mode libraries before being processed by the conversion utility. Both companies modify 16-bit compiler libraries by replacing a small set of memory-management and other services with versions specific to protected mode. For 386-based extenders, applications require compiling and linking with compatible 32-bit tools.

Complex applications may require modification of source code to allow operation with the DOS extender. The developer may need to code separate interrupt handlers and I/O drivers for use in protected and real modes, so the application can retain its functionality regardless of which mode it is in when an interrupt occurs. New applications and those ported from other operating systems also may require dual-mode support.

An application ported to an extender, unlike one ported to OS/2 or Unix, can retain standard DOS and BIOS services for file or device I/O and memory management. To use full linear memory for code and data, an application that uses memory-conservation techniques, such as overlays, should be altered.

Developers also might consider removing accesses to EMS. Extenders allow protected-mode access to expanded memory, retaining compatibility with real-mode versions of the application. In many cases the reason for porting to an extender is to access a large linear-address space, so EMS becomes of questionable value.

Some applications may need major rewriting before they execute in protected mode. For example, self-modifying code is not allowed without tricking the processor by overlaying both data and code segments over the same address range. A program may not perform arithmetic on segment-register contents or on portions of address pointers because those registers and pointers contain selectors rather than segment addresses. Full pointer arithmetic in C and other languages is acceptable if it conforms to the syntax and semantics of the language and memory model. Programs cannot access any memory outside the boundaries of allocated segments, and all interrupts must be hooked by calling DOS services, not by overwriting the interrupt vector table in low memory. If correcting such practices in an existing program is a vast undertaking, rewriting the application may be the only alternative.

An extended application can be delivered to the user either with a stand-alone loader that loads the extender kernel, which in turn loads the application, or with the loader and ker-

TABLE 2: *DOS Extender Features*

	AI ARCHITECTS	PHAR LAP	RATIONAL SYSTEMS
PRODUCT	OS/*x*86	386/DOS Extender	DOS/16M
DEVELOPER'S KIT			
Price	$495	$495	$5,000[a]
Redistribution license			
per copy	●[b]	○	●[b]
unlimited	○	$1,495	○
Protected-mode debugger	●	●[c]	●
Debugger capabilities			
windows	○	○	●
source-level	○	○	●
Protected-mode command interpreter	●	○	○
.EXE file converter	●	○	●
Assembler	○	●	○
Linker	○	●	○
Loader	●	●	●
Bind utility	●	●	●
TECHNICAL FEATURES			
386-specific features	●[d]	●	○
Virtual-8086 support	●[d]	○	○
VCPI compatibility	●	●	●
DESQview compatibility	●	●	○
MS-Windows compatibility	○	○	●
Intermode procedure calls			
to real mode	●	●	●
to protected mode	●	○	○
Segment aliases	●	●	●
Real-mode interrupts	●	●	●
Protected-mode interrupts	●	●	●
Access to video and BIOS data	●	●	●
Access to I/O ports	●	●	●
FCB operations	●	○	●
TSR support	●	●	●
Minimum DOS version	3.0	3.0	2.0
Kernel size (KB)			
conventional memory	42	100[e]	24
extended memory	<64	0	0

● = *Yes* ○ = *No*

[a] *Includes license to distribute 200 copies of a product.*
[b] *Price depends on quantity; contact the vendor.*
[c] *MINIBUG supplied with Developer's Kit; more advanced 386DEBUG available separately for $195.*
[d] *OS/386 version only; OS/286 does not take advantage of any 386 features.*
[e] *May increase up to 200KB, depending on configuration.*

The essential parts of a DOS extender consist of a protected-mode loader, a debugger, and a runtime kernel. The 32-bit versions of the assembler and linker by Phar Lap also can be used to build executables for A. I. Architects's OS/386.

nel bound into the application as a single executable file. In either case, the loader initiates the kernel's bootstrap routine, which in turn sets up control structures (such as descriptor tables), switches into protected mode, and then loads the remaining portions of the kernel and application. The developer controls which portions of the application go into conventional memory and which portions of the application go into protected memory.

Applications can operate solely in protected mode, with the protected-mode kernel handling interrupts and exceptions, managing memory, and emulating most BIOS and DOS services. Applications requiring services that cannot be remapped and performed in protected mode, such as calls to device drivers, need to switch into real mode.

As system calls are made, whether extender-kernel, DOS, or BIOS specific, the kernel switches modes. For real-mode services, the kernel must translate its address information from selector:offset to real-mode segment:offset format, and pass the reformulated parameters to the target DOS or BIOS routine. When the function returns, any returned addresses are translated to protected-mode format, and the kernel switches to protected mode.

For protected-mode TSRs where the application's primary mode is real mode, invoking the TSR activates the real-mode portion, which calls the kernel to switch to protected mode to access the bulk of TSR code or data. Once the protected-mode portion of the TSR completes, the system resumes the application in real mode.

OS/*x*86 FOR ALL

A. I. Architects has the broadest line of DOS extenders. The 16-bit OS/286 can run on most AT or PS/2 compatibles with either a 286 or 386; the 32-bit OS/386 can run on both AT-bus and IBM Micro Channel 386 machines; and the 32-bit OS/386-HB runs on A. I. Architects's 386 accelerator board, the HummingBoard.

The 386 versions support both segmentation and paging capabilities of the 386. Under OS/386-HB, real-mode tasks can operate concurrently on the system unit; protected-mode tasks operate on the HummingBoard, which can be used with any 8086, 80286, or 80386 processor compatible with the IBM PC/XT and AT.

Table 2 lists several tools provided by A. I. Architects for creating an extended application. Applications developed with standard DOS compilers and linkers must be converted using the porting utility, EXPress, to prepare them for protected-mode operation. During installation, library routines provided with 16-bit compilers must be replaced with routines provided by A. I. Architects.

Executable files created with Microsoft or Phoenix linkers must be converted to protected mode using the EXPress utility. Applications created with Lahey and MetaWare compilers and linked with Lahey or Phar Lap linkers run in protected mode without conversion.

A. I. Architects's CP utility combines a command processor (such as COMMAND.COM) and a debugger (such as SYMDEB) for loading protected-mode applications. It supports symbolic debugging, but not source-level debugging or windowed displays.

OS/*x*86's stand-alone loader, called UP, loads the system kernel and executable code for the application; each re-

TABLE 3: *Development-tool Support*

	AI ARCHITECTS[a]	PHAR LAP	RATIONAL SYSTEMS
PRODUCT	OS/x86	386/DOS Extender	DOS/16M
16-BIT TOOL SUPPORT			
Aztec C	○	○	●
Borland			
Turbo C	●	○	○
Turbo Pascal	●	○	○
Lahey			
F77L-EM/16 FORTRAN	●	○	○
Link-EM linker	●	○	○
Lattice C	●	○	●
LogicWare Prolog	●	○	○
Logitech Modula	○	○	●
MetaWare			
High C	●	○	●
Professional Pascal	○	○	●
Microsoft			
Assembler	●	○	●
C	●	○	●
FORTRAN	●	○	●
Linker	●	○	●
Park Place Smalltalk	●	○	○
Phoenix Linker	●	○	●
Rational Systems Instant C	○	○	●
WATCOM C	○	○	●
32-BIT TOOL SUPPORT			
Alsys ADA	○	○	●
Laboratory Microsystems FORTH	○	●	○
Lahey			
F77L-EM/32 FORTRAN	●	○	○
Link-EM/32 linker	●	○	○
Language processors			
FORTRAN	○	●	○
BASIC	○	●	○
COBOL	○	●	○
PL/1	○	●	○
Meridian ADA	●	○	○
MicroWay NDP FORTRAN	○	●	○
MetaWare			
80386 High C	●	●	○
Professional 386 Pascal	○	●	○
Phar Lap			
Assembler	●	●	●
Linker	●	●	●
RNR Software ADA	○	●	○
STSC APL	○	●	○
Symbolics LISP	○	●	○

● = *Yes* ○ = *No*

[a] *OS/386 requires 32-bit versions.*

The 286 extenders require protected-mode libraries; 386 extenders require 32-bit protected-mode versions of compilers, assemblers, linkers, and libraries.

load requires the kernel to be loaded from disk. Version 2.0 of OS/*x*86, to be released in the first quarter of 1989, includes a modified kernel that remains resident in memory as a TSR program so subsequent reloading of an application does not require reloading the system kernel.

An application can be bound with the kernel and loader into a single executable file using A. I. Architects's Bind utility. A bound application does not use the resident kernel, but loads it from disk every time.

The Developer's Kit (for $495) includes the loader and kernel (UP), the EXPress utility, the protected-mode command processor (CP), link-time library modifications, and example source code. The Bind utility is not provided until the developer signs a runtime license. The price of runtime distribution for a bound application is based on a percentage of the price of the complete application. The OS/386 Developer's Kit with HummingBoard (16-MHz 386 with 1MB of RAM) is $1,595. It is also available in higher memory configurations and faster processor chips.

A protected-mode application is initiated by loading the kernel and application using the UP loader, or by using CP. In release 2.0 of OS/386, a real-mode application is loaded, not into protected mode, but into a separate V86-mode context, using extended memory to give the application a full 1MB of memory, apart from TSRs and other programs residing in conventional memory.

In protected mode, tasks run at privilege level 3, the lowest level; the OS/*x*86 kernel operates at level 0, the highest. An application in protected mode can execute a real-mode application. In OS/386, real-mode applications are executed in V86 mode rather than in real mode. An application also can execute or spawn protected-mode applications. OS/*x*86 creates a protected-mode context and an LDT for the new program. When the spawned program terminates, the kernel returns to the original application.

OS/*x*86 can handle hardware and software interrupts in both real and protected modes, depending on whether the developer has included protected-mode interrupt handlers in the application. In both modes, the kernel intercepts the DOS set-interrupt-vector function. If the application points an interrupt vector to a real-mode handler, then the kernel establishes a surrogate interrupt handler in

protected mode. The reverse is true if an interrupt is set in protected mode. If an interrupt is received by a surrogate—that is, if it occurs in a different mode from where the vector was hooked—then the surrogate handler changes modes and passes the interrupt to the original handler. On completion, the processor mode is set back to what it was before the interrupt.

Handlers for the same interrupt source established in each mode avoid mode switching. Chaining interrupts is supported in either mode, but chaining between modes is not allowed. Interrupt handlers can be established by using the DOS set-interrupt function. Modifying the interrupt table in real mode is self-defeating; because the kernel is unaware of the interrupt, it will not establish the proper control structures, such as entries in the protected-mode interrupt descriptor table (IDT) for all registered interrupt handlers.

For memory management, OS/*x*86 has extended services for creating and manipulating data and code segments and for transferring data between segments. OS/*x*86 allows creation and deletion of what A. I. Architects calls *windows*. These are not areas on the screen, but rather memory-management objects that can overlay one or several predefined memory regions. These windows are treated like other code and data segments, but are not limited by hardware. A single large window could span several 64KB segments, even on a 286 system.

Using OS/*x*86, the developer also can access segment information, change the segment parameters (for example, change segments from code to data), and transfer blocks of memory without regard to protection limitations.

A robust set of services for intermode communications passes data between real- and protected-mode procedures. A protected-mode procedure can load a real-mode overlay, then call it with a real procedure call (RPC). The RPC can transfer up to 4KB of data, using a dynamically allocated transaction buffer. Alternately, data can be passed between modes in memory segments allocated with the OS/*x*86 memory-management services. Instead of loading a real-mode procedure as an overlay at call time, the developer can bind it into the loader so it is resident when OS/*x*86 starts.

RPCs are used by the interface routines provided by A. I. Architects to access the HALO graphics library—a subroutine of Image-Pro from Media Cybernetics (Silver Spring, Maryland). These stub routines allow use of the unmodified real-mode HALO graphics library by a protected-mode program. Calling real-mode procedures is most beneficial when a protected-mode program needs library services that cannot be converted to protected mode because source code is unavailable.

A real procedure signal (RPS) provides communication from real mode to protected mode. A real-mode procedure generates a software interrupt to

OS/x86 by A. I. Architects span both 286 and 386 and provide extra support in interactions between real and protected mode.

the protected-mode procedure, using a handle posted by the protected-mode procedure in the RPS table.

An important benefit of implementing RPCs and RPSs is the ability to execute protected-mode procedures on the HummingBoard in parallel with real-mode procedures on the system board. This dual-mode operation is supported transparently by the OS/386-HB kernel, so parallel processing occurs with no effort on the developer's part if an application migrates from the uniprocessor OS/386 environment to a dual-processor environment.

PHAR LAP FOR 386 ONLY

Phar Lap's 386/DOS-Extender operates only on 386-based systems, including AT-bus and Micro Channel machines and XT compatibles with 386 accelerator boards. 386/DOS-Extender is fully compatible with VCPI.

The Phar Lap developer's kit ($495) includes the protected-mode loader and kernel, Phar Lap's own 16-bit assembler and linker, and a protected-mode debugger called MINIBUG (see table 2). An unlimited distribution license for $1,495 includes a binder for combining the application and kernel into a single executable file that the DOS loader can start. A more powerful symbolic debugger, 386DEBUG, is available separately for $195; neither debugger, however, supports source-level debugging.

Because it is a 386-only product, Phar Lap's extender requires use of 32-bit, 386-compatible assemblers, compilers, and linkers, as listed in table 3. Object files produced by these tools can be linked using the Phar Lap 386 Linker. The resultant protected-mode executable can be loaded without further conversion by using Phar Lap's protected-mode loader, RUN386.

The runtime kernel, integral to the loader, occupies about 100KB and, depending on system configuration, can grow to 200KB. The loader establishes a GDT for the kernel and an LDT for the application. Despite the flat address space, the loader creates separate selector code and data space for the application and establishes selectors for often-used BIOS, video memory, and other data areas. The application and kernel both execute at privilege level 0, the highest level.

Operating in both real and protected modes, the kernel intercepts DOS and BIOS interrupts from the application. The kernel either performs the request itself or translates the arguments, switches to real mode, and calls the original DOS or BIOS procedure.

Phar Lap's APIs are the same as DOS, using the same functions of INT 21H. Although most functions are enhanced for protected-mode operation, the similarity with DOS is welcomed by DOS developers.

386/DOS-Extender provides several ways to communicate between protected- and real-mode procedures. One way is to pass the real-mode value of all registers to the real-mode procedure; another passes only the CS register contents. Both methods permit using the stack for passing additional data, which are copied from the caller's protected-mode stack to the target's real-mode stack. The calling procedure must know the address of the real-mode procedure. The two procedures can be linked together into one executable file (the linker then resolves the address), or the real-mode procedure can pass its address via a transfer buffer or software interrupt.

The kernel provides a single transfer buffer, up to 64KB, for data transfer between real- and protected-mode procedures. It resides in conventional memory; both real- and protected-mode procedures can obtain its address by calling a kernel function. An application could, for example, use this buffer to pass the address of a real-mode routine to be called from protected mode. A real-mode procedure also can call a protected-mode procedure, but this requires the developer to write a convoluted protocol for passing addresses and parameters.

All interrupts, including the software interrupts, hardware interrupts, and processor exception traps, are routed to real mode unless they are redirected using the 386/DOS-Extender set-vector function. On a 386 system, switching to real mode for all interrupts does not involve the overhead of a 286 system.

Kernel API services set real- and protected-mode interrupt vectors separately, allowing distinct interrupt handlers for each mode; or a single service sets both vectors at the same time, preventing race conditions by disabling interrupts while both vector addresses are established.

Dual-interrupt handlers allow applications to control mode switching. A procedure in one mode calls the software interrupt for the other mode's interrupt handler.

The 386/DOS-Extender allows one program to spawn another. Although similar to the DOS EXEC function, it does not restore the interrupt vectors to their default state before executing the new program. Thus, the parent protected-mode program can gain control of the child real-mode program without an interrupt crashing the system if the vector is redirected.

The extender allocates memory in 4KB pages, from conventional memory first, followed by extended memory. It allocates extended memory from the top down. Any pages freed in the middle of a set of pages belonging to a process will not be available for reallocation until the application exits. The kernel establishes LDT entries for each new memory block allocated. The developer can request creation of *segment aliases*, which are duplicate selectors that allow the same segment to appear as both code and data.

The 386/DOS-Extender supports VCPI to coexist with V86-mode control programs, such as DESQview and 386-to-the-Max. It will not remap hardware interrupts if DESQview is present.

Phar Lap has made available 386/VMM, a virtual-memory manager to use with the 386/DOS-Extender to allow access to a memory size limited only by disk capacity. It uses the demand-paging capability of the 386 to swap memory to and from disk storage.

SMALL AND SPUNKY DOS/16M

DOS/16M from Rational Systems can be used on both 286 and 386 systems. Its kernel is the smallest of these extenders, roughly 24KB. The kernel's small size and close compatibility with DOS calls that support TSRs make it a good candidate for protected-mode TSRs. After hooking interrupts and installing the resident portion in extended memory, only a small stub remains in conventional memory. When an interrupt awakens the TSR stub, it calls a kernel service to enter protected mode and execute the main body of code in extended memory. Rational Systems includes example TSR code in its developer's kit.

DOS/16M provides compatibility with all DOS and BIOS calls, as well as an extended set of kernel services. It does not include V86-mode or specific 32-bit support, but its VCPI compatibility allows it to cooperate with other protected-mode control programs running on a 386.

Phar Lap's 386/DOS-Extender has been expressly designed for high-performance applications in the 386 32-bit environment.

The extender's features are listed in table 2. A broad range of 16-bit DOS-based assemblers, compilers, and linkers supported is listed in table 3. Executable files built with Microsoft or Phoenix linkers must be converted to protected mode using the Rational Systems's MAKEPM utility, similar to A. I. Architects's EXPress. Files produced by the Phar Lap linker require no post processing.

The protected-mode executable can be loaded using either Rational Systems's LOADER, its Instant-D debugger, or a developer-created loader. The developer can bind the kernel, loader, and application into a single executable file using the SPLICE utility.

Instant-D is a powerful source-level debugger using a windowed environment similar to Microsoft's CodeView. When running on a 386, Instant-D uses the extended debugging support provided by that chip's hardware debugging registers (see Tech Notebook, January 1989, p. 121).

An initial developer's license (IDL) from Rational Systems costs $5,000 and includes a developer's kit and a license to embed the product in up to 200 copies of an application. The kit includes the loader, kernel, debugger, bind utility, protected-mode libraries for high-level compilers (see table 3), and example source code. Additional developer's licenses are available for $1,000. A developer's site license costs $15,000 after purchase of an initial IDL.

Both the kernel and the application operate at privilege level 0. The application can generate real-mode interrupts to access DOS or other TSR functions, and can create overlaid segments to allow access to BIOS and video-data areas. The kernel supports all DOS and BIOS services, most in protected mode. DOS/16M recognizes when it is operating on a 386 and uses the faster mode-switching capability of that chip.

All 31 of DOS/16M's API services are functions called with standard C syntax. Services include those for interrupt maintenance, memory, and process management.

For intermode communications, DOS/16M includes a function similar to the RPC facility of OS/x86, allowing a protected-mode procedure to call a real-mode one. Unlike the other extenders, it does not provide facilities for handling transaction buffers or copying the stack between modes, but it passes a selected set of registers to the called procedure.

DOS/16M has functions for switching the processor between real and protected modes, leaving the physical address unchanged through the switch. With the segments in each mode overlaid on the same memory area, a procedure in one mode can call an interface procedure in the same mode. The interface procedure then would switch to the new mode, perform the process, then switch back to the original mode, and return.

Interrupts can be handled in either real mode, protected mode, or both. DOS/16M intercepts and translates BIOS and DOS services. If the DOS set-interrupt service is called, DOS/16M installs a protected-mode interrupt vector in the IDT and adjusts the real-mode interrupt routine to pass up the interrupt to the protected-mode interrupt handler.

Pass-up interrupts, which occur in real mode, cause DOS/16M to switch to protected mode and regenerate the interrupt to the protected-mode handler. Pass-down interrupts, received in protected mode, cause the kernel to switch to real mode and regenerate the interrupt to the real-mode handler.

The kernel handles processor exceptions in protected mode. Interrupt handling is performed in the mode where it occurs to prevent the slower

mode switching of the 286. However, the developer can specify unconditional handling of individual interrupts. For example, an I/O device may have a real-mode device driver, so interrupts from that device are restricted to real-mode only. DOS/16M redirects to real mode any interrupts received from the device while in protected mode.

Applications use DOS memory-allocation services intercepted and translated by DOS/16M. An extended set of memory-management services affords greater control, including services to alter the strategy of memory allocation. The strategy establishes the mode and location in which memory will be allocated, for both standard DOS and kernel memory-management functions. For example, the developer can indicate whether memory is allocated out of low or extended memory. The allocated memory also can be made transparent, meaning the memory segment (either code, data, or stack) has the same address in both protected and real modes. The memory-allocation strategy is maintained for all memory-management calls until it is replaced by another strategy definition.

Alias selectors define overlapping memory space with each selector defining different attributes. A selector can be canceled and later reused without deallocation, or it can be freed, which cancels and deallocates it. Selector attributes can be modified on the fly, and pointers can be converted between real and protected modes.

Rational Systems's LOADER utility provides limited compatibility with Microsoft Windows, in that LOADER can be spawned by a window procedure. LOADER then loads the extender kernel and the application and executes them as it would a separate DOS application.

DOS/16M is compatible with expanded-memory drivers, supporting INT 67H EMS functions that provide basic allocation and page-mapping services. It supports handle-based DOS file I/O functions but only a limited subset of the old-style DOS file control block (FCB) I/O functions.

A KINDER, GENTLER DOS

DOS extenders can enhance performance of many DOS applications currently bumping against the limits of their environment without requiring radical changes from developers and users. Applications ported from mainframes and minicomputers now have more room to maneuver in DOS than ever: the linear 32-bit address space in protected mode obviates the need for segmentation.

The decision of whether to attempt a DOS port with an extender or upgrade a current DOS-based product to give it enhanced capabilities will have to be weighed against moving to OS/2 or Unix. Several factors tip the scales in favor of the DOS extender route. Either operating system with its support utilities consumes more disk space than an extender and DOS. The cost of hardware to support Unix or OS/2 is also more than that of a system that runs an extended application of comparable scope. But the most telling argument is that a developer who chooses a DOS extender does not have to convince anyone to follow suit—the user of the application does not need to know or care about the developer's decision, which is not the case when moving to Unix or OS/2.

The smaller kernel of Rational Systems' DOS/16M lends itself to use in TSRs and on platforms with limited extended memory.

DOS extenders may keep DOS ahead of Unix in the marketplace. When and if a consistent user interface takes hold in the Unix community and many popular DOS applications are available on Unix, the multitasking aspects of Unix may shift users to its direction, away from an enhanced DOS.

The situation is similar for OS/2. Many popular DOS applications will have to be available at a reasonable price, both for the application and the platform, before users shift to that direction. Enhanced DOS applications may slow down that shift. Until a 386 version of OS/2 is available, both Unix on the 386 and DOS with a 386-based extender have an edge in the use of 386 systems.

When choosing among the three available DOS extenders, consider these points. A. I. Architects's OS/*x*86 systems efficiently span both 286 and 386 and provide extra support in the interaction between real- and protected-mode processes. These extenders are especially strong in separating code spaces where a portion of a pre-existing product or a library set must be retained without being ported to protected mode.

Phar Lap's 386/DOS-Extender has been designed expressly for the 386 32-bit environment. It might be best for high-performance applications that need not run on slower platforms. Its virtual memory capability gives it an extra advantage for multi-megabyte applications, allowing them to run in smaller amounts of physical memory. Finally, it is the only extender of those reviewed with a fixed-cost, unlimited-distribution license.

The smaller kernel of Rational Systems's DOS/16M lends itself to use in TSRs and on platforms with limited extended memory. It is compatible with both 286 and 386 platforms, but does not use the paging and linear 32-bit address capabilities of the 386.

No matter which extender is selected, the numbers and types of applications ripe for porting to a DOS extender are immeasurable. Almost any product can benefit from expanding its feature set through greater code size and data-handling capability. As more popular products are ported, they may become an accepted norm, rather than a curiosity. With DOS extenders, DOS never looked better.

A. I. Architects Inc.
One Intercontinental Way
Peabody, MA 01960
508/535-7510
OS/286 Developer's Kit: $495
OS/386 Developer's Kit: $495
OS/386 Developer's Kit with HummingBoard (16-MHz 386 with 1MB of RAM): $1,595
CIRCLE 337 ON READER SERVICE CARD

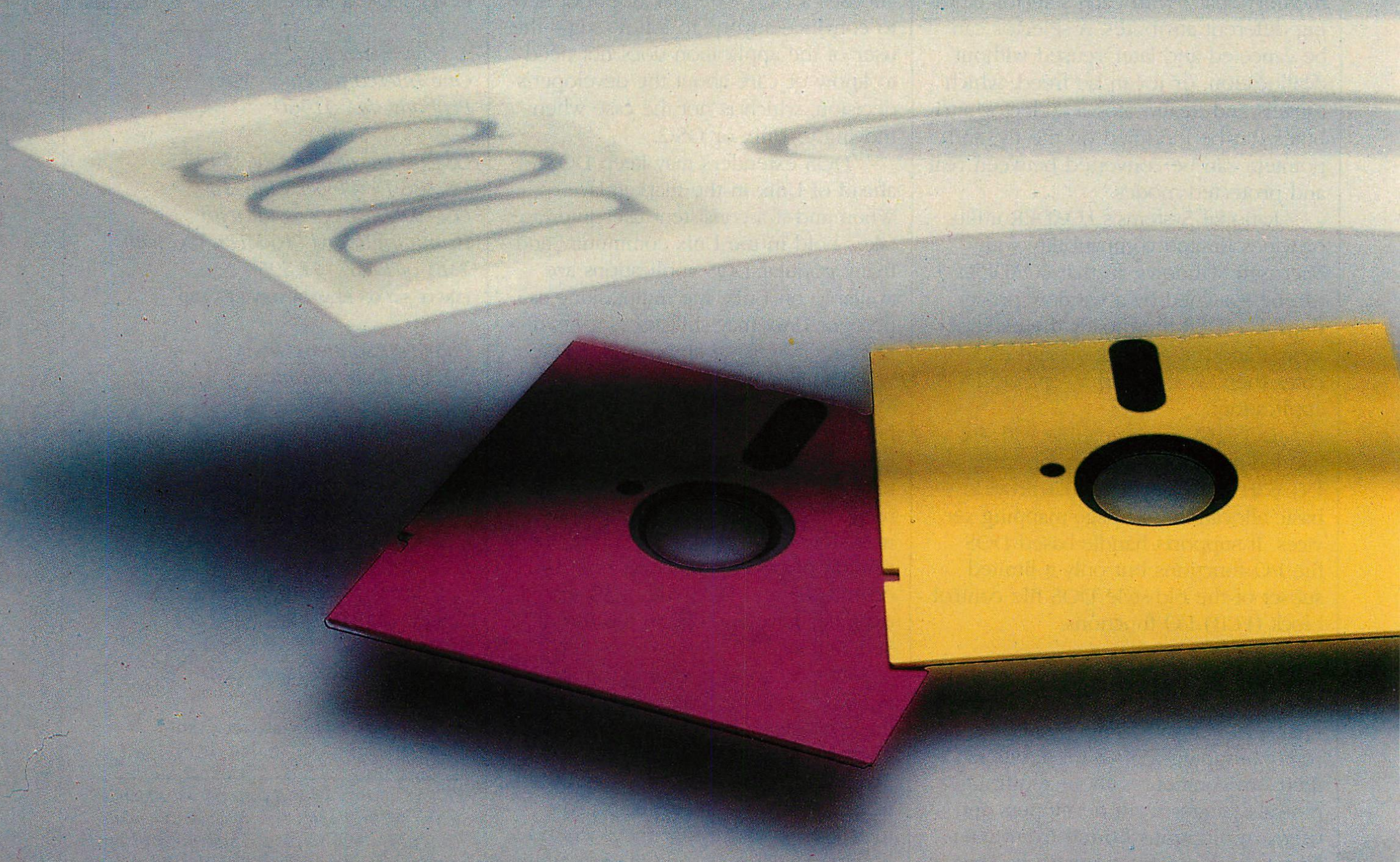
Phar Lap Software Inc.
60 Aberdeen Avenue
Cambridge, MA 02138
617/661-1510
386/ASM/LINK: $495
DOS-Extender runtime license: $1,495
CIRCLE 338 ON READER SERVICE CARD

Rational Systems Inc.
220 North Main Street, Suite 203
Natick, MA 01760
508/653-6006
DOS/16M initial developer's license: $5,000
CIRCLE 339 ON READER SERVICE CARD

William E. Brooks is a founder of Applied System Technologies Inc. of Ft. Lauderdale, Florida. He has developed systems and applications software under DOS and other real-time and multitasking operating systems.

COVER SUITE:
STRETCHING DOS

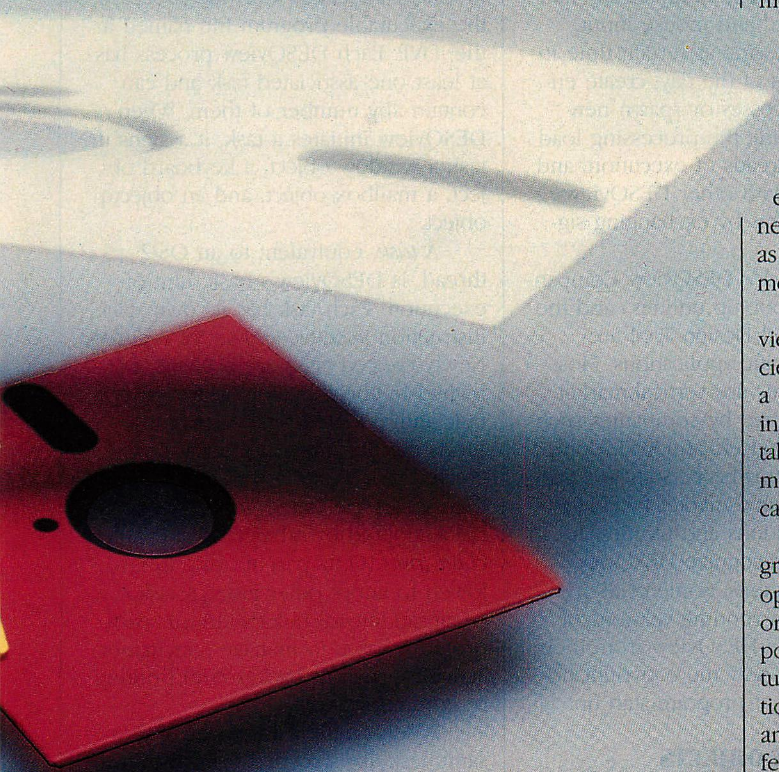
Drawing Out DESQview



Power

DESQview can multitask most DOS applications, but its full power is available only to programs written using its API. The API lets programs control their environment instead of being controlled.

FREDERICK J. HITT



Unless you have been living in a cave for the last several years, you already know that Quarterdeck Office Systems' DESQview is a popular operating environment for multitasking DOS applications. Loading DESQview on your PC can mean expanding the DOS environment considerably, allowing multiple existing DOS applications to run at the same time.

What you may not know is that, by using DESQview's application program interface (API), DOS applications can make better use of the screen, keyboard, and memory they share with other programs in the DESQview operating environment. This improves the performance of each application.

What types of programming tools do APIs provide? Are they comprehensive, flexible, easy to use? Can systems developers use them for enhancing existing applications, as well as for building new ones? Will APIs make DESQview even more attractive as integrators look for more functional operating environments than "plain old DOS?"

One advantage of DESQview over OS/2 is that DESQview does not need specially written programs but can efficiently execute and multitask most DOS applications. (For a closer look at DESQview's multitasking, see "386 Operating Environments," Ed McNierney, January 1988, p. 60.) To take advantage of the advanced features of the environment, however, programs must be written specifically to call on those features through the DESQview API.

The DESQview APIs are a set of function calls a program can use to interact with and control the DESQview operating environment. APIs provide a multitasking, object-oriented environment with control over the keyboard, pointing device, screen windows (the primary data structures manipulated by DESQview), intertask communications, timers, and message queues for posting messages among the various DESQview objects. It has many of the features of OS/2's API, including support for an equivalent of the OS/2 dynamic link library (DLL) facility. (For a de-

ILLUSTRATION • STUDIO 65

scription of OS/2 DLLs, see "OS/2's Dynamic Link," Mary DeWolf and Ted Mirecki, September 1988, p. 100.)

The DESQview API Toolkit ($500) includes the *API Reference Manual*, function libraries for assembly language and C (supporting Lattice, MetaWare, Microsoft, and Borland compilers), the Panel Design Tool, and a multitasking debugger. These components are also available separately, as is a library for Turbo Pascal. The minimum a developer needs to get started is the reference manual ($59.95) that defines the assembly language calling conventions of the API.

DESQview classifies programs depending on their use or nonuse of APIs into one of three categories: DESQview-oblivious, DESQview-aware, or DESQview-specific.

A *DESQview-oblivious* program is written without consideration for DESQview APIs. When a program performs hardware-specific screen-manipulation functions, such as writing directly to the video buffer, it is called *ill-behaved;* a program that uses DOS or BIOS calls for video access is *well-behaved*. AutoCAD and Microsoft Word are examples of DESQview-oblivious programs. DESQview's Add A Program function assumes that the program being installed is DESQview-oblivious, and successfully loads and executes it. By setting the installation parameters to the specific program classification, developers can maximize a program's performance under DESQview.

A *DESQview-aware* program uses a limited set of DESQview API calls to determine the presence of DESQview, and behaves differently when executing under DESQview than when executing under DOS. For example, a program that writes directly to the video buffer under DOS can, using DESQview, ask the environment to provide a logical video buffer instead. DESQview can then manage the program's screen output and display it in a window that shares the screen with output from other applications. WordPerfect and Paradox are examples of programs that use a subset of DESQview APIs to become DESQview-aware. The systems integrator installing a program into the DESQview environment can determine if the program is DESQview-aware by monitoring execution with the DESQview API debugger.

A *DESQview-specific* program is written to take advantage of the environment created by DESQview; it needs DESQview to operate and will not run under DOS alone. Using the API services, DESQview-specific programs can create and control output windows; limit or extend the DESQview user interface; define forms, menus, and other interactive controls; let the environment automatically handle all keyboard and mouse input; schedule processing at certain time intervals or times of the day; create entirely new processes or spawn new subtasks to divide the processing load into parallel threads of execution; and communicate with other DESQview-specific programs by exchanging signals and data.

TABLE 1: ***DESQview Objects***

OBJECT	DESCRIPTION
Keyboard	Gets window-specific user input
Mailbox	Provides inter-task communication
Objectq	Queues input messages from devices or tasks
Panel	Aggregates menus, dialog boxes, and other interactive controls for a window
Pointer	Receives input from a pointing device such as a mouse or light pen
Timer	Measures elapsed time or waits for specified time of day
Window	Displays information to the user

DESQview-specific programs control the environment by calling functions to manipulate seven objects, including keyboard, window, and mailbox.

Quarterdeck's DESQview Companions (a set of pop-up utilities) and the DESQview Panel Design Tool are DESQview-specific applications. Most such applications are vertical-market systems developed by companies such as US Data, Cybertek, and MCI. Companies, such as Strawberry Software, are developing general-market DESQview-specific applications and utilities. It can be difficult to recognize DESQview-specific applications. Some of them, distributed with runtime versions of DESQview, hide DESQview from their users, allowing only the copyright notice to be seen at program start-up.

SEVEN LITTLE OBJECTS

DESQview APIs provide an object-oriented interface. An application using it tells DESQview how to create and manipulate seven different objects, or data structures (window, objectq, panel, keyboard, pointer, mailbox, and timer) listed in table 1. The power of the DESQview environment comes from the APIs' ability to manage the relationships among these objects.

The design of DESQview's APIs closely adheres to that of its IBM predecessor, TopView. Like TopView, DESQview makes a close association between tasks and windows. Because developers differentiate tasks (code to be executed) from windows (visual interfaces to the user), this close association can be confusing. The structure of the DESQview environment would be clearer to developers if tasks were an object category in their own right.

The first consideration is the window object. Developers must understand the relationship among DESQview's processes, tasks, and windows. DESQview isolates programs from each other by running each as a separate process. A DESQview process is a software-created virtual machine environment that allows a program to see what it believes is a contiguous address space for its code and data, including its own copy of DOS, BIOS, and interrupt vectors.

DESQview invokes processes based on the contents of a DESQview program information file (.DVP). The first task associated with the process is the executable program file named in the .DVP. Each DESQview process has at least one associated task and can contain any number of them. When DESQview initiates a task, it assigns the task a window object, a keyboard object, a mailbox object, and an objectq object.

A *task*, equivalent to an OS/2 thread, is DESQview's basic unit of execution. Each task has its own stack, instruction pointer, and set of registers. Newly created tasks are *orphans*, not owned by their creator or any other task until adopted by whatever task sends the first message to the newly created task window. Tasks that adopt themselves are called *parent tasks*; tasks adopted by other tasks are called *child tasks*. Only parent tasks are allowed to adopt other tasks. A task can create additional tasks within its own program space to manage concurrent activities, such as background printing or communications.

When multiple instances of the same task are spawned from within the code space of a parent task, the developer must ensure that the code is reentrant. Each instance of a reentrant task can allocate its own data space or share common data space allocated externally by entries in the .DVP file.

TABLE 2: *Process and Task-related APIs*

FUNCTION	DESCRIPTION
api_freebit	Disconnect second-level interrupt handler
api_getbit	Define second-level interrupt handler
api_setbit	Schedule a second-level interrupt handler
app_foreonly	Limit an application to foreground only
app_free	Free an application and its window
app_goback	Force an application into background
app_gofore	Force an application into foreground
app_hide	Hide all windows of an application
app_new	Start a new application in the current process
app_number	Get the current application's switch-list number
app_show	Display all windows of an application
app_start	Start a new application in a new process
app_suspend	Suspend and hide all tasks in an application
tsk_free	Free a task and its window
tsk_me	Get handle of current task
tsk_new	Create a new task
tsk_pgmint	Software interrupt another task
tsk_post	Restart a task and post its objectq
tsk_start	Restart a stopped task
tsk_stop	Temporarily stop a task
win_adopt	Adopt a window or task
win_allow	Specify which DESQview commands are allowed
win_cancel	Cancel notification of task-related events
win_disallow	Specify which DESQview commands are not allowed
win_disperor	Display an error message window
win_notify	Enable notification of task-related events
win_orphan	Orphan a window or task

An application runs as one or more processes, each consisting of one or more tasks. Each process has its own address space, which is shared by all of its tasks.

DESQview allows similar functional capabilities for code and data sharing as does OS/2.

DESQview selects tasks for execution in a round-robin manner and allows each task to execute for a fixed time slice. The user can alter time-slice values through the DESQview configuration program, DVSETUP. Tasks associated with pending user input are given highest priority.

A *window* is an object representing a rectangular area on the screen in which a task displays information. All information a task presents to its user, including normal output, menus, error messages, and help screens, is displayed in a DESQview window. DESQview automatically allocates a *task window* to each task for normal output. DESQview allows the user or the application to move, resize, color, hide, and redisplay windows.

All API functions that display information to the user operate on window objects. Because DESQview assigns a window object to each task at task initiation, all API functions for task management are actually operations on window objects. DESQview maintains a window list containing the handles of windows opened by all tasks, sorted in display order with the active window at the top of the list. Applications can change ordering in the list via calls to the APIs. By default, DESQview groups all windows for a given application together, including those currently hidden by other windows. When a user switches an application to the foreground, DESQview automatically moves all of its windows to the top of the window list.

Windows can be created with or without frames. A single-line and a double-line box surround windows associated with background and foreground applications, respectively. Framed windows can also contain descriptive titles that an application can control via the API.

For each window, DESQview allocates a *logical window buffer* that stores information displayed to the user. The buffer's size can vary from 0-by-0 to 127-by-127 characters. The application that owns the window can dynamically change the buffer's size.

The amount of information visible to the user depends on the placement and size of the *physical window* associated with the logical window buffer. Both the user and application can control the size, placement, and visibility of the physical window. DESQview automatically redraws the contents of any window manipulated by the user or program, without assistance from the task owning the window. In contrast, under OS/2's Presentation Manager, the application that owns the window must redraw any windows changed by the user or other applications.

Programs ultimately invoke DESQview APIs with software interrupts, passing parameters both on the stack and in registers. Although the APIs are designed for assembly-language programs, Quarterdeck provides libraries of high-level glue functions for Turbo Pascal, Microsoft Quick BASIC, and C compilers from Borland, Lattice, MetaWare, and Microsoft. All DESQview API example calls referenced here use the Microsoft C version of the DESQview API. High-level libraries are supplied in source form for compilation with the compiler of the developer's choice. Quarterdeck recommends compiling for the large-memory model because the APIs use far pointers; with care, the developer can build a mixed-model library for calling from small-model programs.

The API library contains more than 200 calls to DESQview. Learning to use them effectively is a significant exercise, with the documentation offering scant help. Quarterdeck's C-Library documentation breaks the calls into 12 categories, with the first section explaining general utility functions that are not object related, such as api_beginc and api_exit. One weakness in the DESQview documentation is lack of adequate cross-referencing between API calls and the DESQview objects to which they relate. Tables 2 through 10 attempt to remedy this deficiency; functions that deal with more than one type of object appear in more than one table. The API functions listed in table 2 are process and task related; table 3, non-object specific; table 4, objectq related; and table 5, window related.

Most DESQview API functions are invoked by calling INT 15H with AH containing a function code of 10H, 11H, or 12H. Two calling protocols exist. The *send interface*, containing the majority of DESQview API services, is the object-oriented portion of APIs for sending messages to the various DESQview objects. In this calling protocol,

register BH contains the identifier of the type of message, and register BL contains the type of the receiving object. Parameters, such as the handles, which identify the instances of receiving objects, are passed as 32-bit quantities on the stack. Results, if any, are returned as 32-bit values on the stack.

The *direct-call interface* invokes functions that are not object oriented or for which a register-based protocol is more convenient than the stack-based send interface. Like the DOS API, the call interface passes parameters and returns values in registers. Most calls invoke INT 15H, but several services are provided by extensions to INT 10H (video) and INT 21H (DOS).

The DVPRESENT call determines if the program is executing under DESQview or DOS. It uses DOS INT 21H, function 2BH (set date), passing an invalid date (CX='DE' and DX='SQ') and zero in the BX register. Under DOS, the function returns with an error code in AL and BX unchanged. Under DESQview, the function returns the DESQview version number in BX.

The SHADOW call asks DESQview for a window buffer address that the program can use in lieu of directly addressing the physical video buffer. The call invokes DOS interrupt 10H with AH set to 0FEH; if DESQview is not present, this does nothing. Once a SHADOW buffer is allocated, DESQview automatically updates the screen to reflect changes to that buffer. Alternately, the program can use the UPDATE call to request that DESQview update specific portions of the SHADOW buffer. Once the program issues an UPDATE call, DESQview stops automatic updating of the shadow buffer.

A TASK WITH A PURPOSE

In any environment, a task alternates between waiting for and processing input. Tasks with only one input source, such as the keyboard, can call a read procedure that does not return until input from that source occurs. DESQview-specific tasks, however, often have additional sources of asynchronous input such as interval timers, mailboxes, or a pointing device. For a task having multiple inputs, suspending the task while waiting for one input often causes delays in responding to other inputs.

The DESQview *objectq* is designed to remove these delays. It is a queue to which DESQview posts the identifying handle of the originator of all task input on a message-by-message basis. Although DESQview automatically creates an objectq for every task, the task must open or read the objectq in order to activate it.

When input becomes available for any object owned by a task, DESQview adds the handle of the target object to the objectq input list (provided the objectq is open). Each time a task reads its objectq, DESQview presents the handle of the next object with pending input, or suspends the calling task until input is available. DESQview adds handles to the objectq in the order that input events occur, so objects with more than one message pending appear more than once in the objectq.

The objectq should be used for serialized processing of multiple inputs. By reading the objectq instead of the input objects directly, an application ensures processing of events in the order they occur. Because DESQview posts a new handle for each input to an object, tasks should read an object's input only once for each time that object's handle occurs in the objectq.

Input events are not the only way of creating entries in the objectq. Any task can write to any other task's objectq, which generates signal events among cooperating processes.

DESQview-specific applications use Window Stream, Query Stream, and Manager Stream messages to interface with their windows. Window Streams control the contents and positioning of a window, and Query Streams obtain this information about a window. Query Streams are useful when a task inherits a window that it did not define and needs information regarding its content, position, color, and other characteristics. For example, in DESQview's Mark and Transfer function (which moves data between windows), the source task places a frameless window around the area to be transferred. The target task inherits the frameless window and can access both the data and attributes of the marked text using the Query Stream API calls.

Applications use the Manager Stream to allow the user to interact with the application, DESQview, and other applications. The Window Manager controls this interaction, invoked by a hot key from within any application. By default, the hot key is the Alt key, but the user can reconfigure it with the DVSETUP program.

Developers can combine multiple menus, dialog boxes, and other interactive controls into a single entity called

TABLE 3: ***Non-object-specific APIs***

FUNCTION	DESCRIPTION
api_beginc	Begin critical region
api_cancel	Cancel current Window Manager operation
api_endc	End critical region
api_exit	Exit application programming interface (API)
api_getmem	Get system-memory buffer
api_init	Initialize API interface
api_isobj	Determine if a given handle is valid
api_level	Define API revision level that application requires
api_pause	Give other tasks a chance to run
api_poke	Display debug information on bottom line of screen
api_putmem	Return system memory buffer
api_sound	Make a sound

While the DESQview API functions are primarily object-oriented, general utility functions perform activities not directly related to any type of DESQview object.

TABLE 4: ***Objectq APIs***

FUNCTION	DESCRIPTION
obq_close	Close the task's objectq
obq_erase	Erase contents of the task's objectq
obq_open	Open the task's objectq
obq_read	Wait for any object to have input
obq_sizeof	Get count of entries in objectq
obq_status	Determine if the task's objectq is now open
obq_subfrom	Remove an object from the task's objectq

DESQview notifies a task of pending input by putting a message in the task's objectq. This allows the task to wait for input without tying up resources by polling input devices.

a *panel object.* Applications can create one or more individual window objects within a panel object. A panel file can contain all individual panels used by an application. APIs allow programs to assign panels to existing windows or create new windows for each panel invoked by the program. Panels can contain any combination of input, output, or select fields. Table 6 lists DESQview API calls associated with panel objects.

The DESQview APIs allow programs to validate individual fields on a panel during data entry. DESQview manages all user-controlled field navigation by supporting concurrent use of both a keyboard and a pointing device, such as a mouse or light pen, using one of the drivers recognized by DESQview. Programs can receive data on a field-by-field basis for changed fields only, or for all the fields defined on a panel.

Developers should use panel objects to present a consistent user interface. Panel Design Tool allows developers to create and test menus, forms, and dialog boxes displayed via DESQview panel objects at runtime. It increases developer productivity when prototyping and building the final user interface and also reduces the time required to build multilanguage versions of DESQview applications.

Keyboard objects give programs access to user-keyed input. DESQview assigns a default keyboard object to every task, and applications can define additional ones, assigning them to individual windows. Table 7 lists DESQview API calls for keyboard objects.

A task can assign separate logical keyboards to each window in a multiwindow application, which then processes input separately for each window/keyboard combination. This allows the user to "type ahead" before the active window is ready to process the input, then switch windows and type new information into the second window. The first window running in the background can process its preloaded keyboard buffer separately from and in parallel with the input activity of the foreground task.

Messages from a keyboard object identify which window is currently receiving input from the user and control how that input is presented to the application. Developers can subdivide a DESQview window into fields for processing by DESQview's Field Manager. The application can choose to receive input keystroke-by-keystroke or field-by-field. Reading a keyboard object suspends the calling task until the next key is typed (in keystroke mode) or until field input is complete for that window (in field mode).

When creating a task, DESQview automatically opens the task's default keyboard object in keystroke mode and assigns it to the default task window. User-keyed input to the default task window is queued to the default keyboard object on a character-by-character basis as it is typed. The task receives this input one keystroke at a time for processing.

DESQview opens a keyboard object in field mode when the associated window has a *field table.* A field-table

TABLE 5: ***Window-related APIs***

FUNCTION	DESCRIPTION
api_justify	Enable or disable automatic justification in window
api_shadow	Get task's logical window buffer and start shadowing
api_update	Redraw a portion of a task's logical window
fld_altmode	Set alternate field-processing mode
fld_attr	Fill a field with a given attribute
fld_char	Fill a field with a given character
fld_clear	Clear a field
fld_cursor	Move cursor to a field
fld_entry	Change field table entry
fld_header	Change field table header
fld_marker	Define selected-field marker character
fld_reset	Reset selected and modified bits
fld_scroll	Scroll a field
fld_swrite	Write a string into a field
fld_type	Change the type of a field
fld_write	Write characters into a field
key_setesc	Define function to filter keys in field mode
qry_atread	Inquire if read functions return attributes
qry_attr	Get current output attribute
qry_color	Get physical attribute for given logical attributes
qry_ctrl	Inquire if processing control codes
qry_cursor	Get current cursor position
qry_entry	Get field table entry
qry_field	Get contents of a field
qry_frame	Inquire if the window has a frame
qry_frattr	Get current frame attribute
qry_header	Get field table header
qry_hidden	Inquire if the window is hidden
qry_leave	Inquire if write will change attributes
qry_logattr	Inquire if using logical attributes
qry_lsize	Get size of logical window buffer
qry_origin	Get origin of physical window relative to logical window
qry_position	Get position of physical window
qry_size	Get size of physical window
qry_title	Get window's title
qry_type	Get type of field
win_addto	Write characters and attributes to a window
win_adopt	Adopt a window
win_allow	Specify which DESQview commands are allowed
win_async	Define asynchronous notify function
win_atread	Set read mode to read either characters or attributes
win_attach	Attach window to its parent task window
win_attr	Set current output attribute
win_blanks	Write blanks to a window
win_bottom	Make window bottommost in its application
win_buffer	Get pointer to window's logical window buffer
win_cancel	Cancel notification (window-related events)
win_color	Change logical attribute mapping
win_ctrl	Enable or disable interpretation of control characters

FUNCTION	DESCRIPTION
win_cursor	Move window's logical cursor
win_dflt	Change default notify window
win_disallow	Specify which DESQview commands are not allowed
win_disperor	Display an error-message window
win_eof	Inquire if logical cursor is beyond end of window
win_erase	Clear window
win_frame	Enable or disable display of a window's frame
win_frattr	Define window frame attribute
win_free	Remove a window from the screen and free its handle
win_hcur	Display hardware cursor at logical cursor position
win_hide	Mark a window as hidden
win_leave	Leave existing attribute when writing to a window
win_len	Return width of logical window
win_locate	Return which window is visible at given screen position
win_logattr	Use logical and physical attributes
win_lsize	Set window's logical dimensions
win_maxsize	Set window's maximum physical dimensions
win_me	Get current task's window handle
win_minsize	Set window's minimum physical dimensions
win_move	Move physical window
win_new	Create a new window
win_notify	Enable notification on a given event
win_nread	Read characters from a window
win_open	Fill a window with a given character
win_origin	Define part of logical window viewed in physical window
win_orphan	Orphan a window
win_paste	Define window as current clipboard window
win_point	Move mouse pointer to logical cursor position
win_poswin	Position window relative to another window
win_printf	Write formatted data to a window
win_putc	Write a character or attribute pair to a window
win_read	Read rest of current line from window
win_redraw	Redraw a window
win_reorder	Reorder an applications window
win_repattr	Write an attribute to a window *n* times
win_repchar	Write a character to a window *n* times
win_resize	Set physical dimensions of a window
win_scroll	Scroll all or part of a window
win_sizeof	Get number of characters in the logical window
win_stream	Write a stream to a window
win_subfrom	Write attributes to a window
win_swrite	Write a zero-terminated string to a window
win_title	Change a window's title
win_top	Make window topmost in its application
win_topsys	Make window topmost in the system
win_unhide	Mark a window as not hidden
win_write	Write characters to a window

DESQview automatically creates a window for each task. Without doubt, the largest group of DESQview API functions deals with control over window objects.

definition gives DESQview information to handle selection, input, and highlighting of selected fields, and cursor and mouse movement within a window. This allows developers to create menus, dialog boxes, and data-entry forms with field tables, defining which fields the user can select and which can receive input. DESQview does all navigation, selection, and field-entry processing, reducing the code developers must write and maintain for the user interface of their applications.

For field-mode input, DESQview preprocesses keyboard input according to the field definitions in the field table before passing it to the receiving keyboard object. A developer can use DESQview's default or can customize field-editing behavior and rules of navigation, including special action routines for each field or character. Windows assigned to panel objects always have a field table.

DESQview determines which keyboard object receives user input by the ordering of window objects in the window list. The keyboard owner (the window receiving input from the physical keyboard) is the topmost window of the topmost task with an open keyboard object. This is the only window that (if the video mode allows) can display the hardware cursor.

The *pointer object* is the interface between applications and the mouse or any other pointing device, such as a light pen or joystick, that allows the user to select a point on the screen. DESQview API calls allow programs to track the pointing device and respond to button clicks. Developers can assign multiple pointer objects to specific windows. Windows with field tables assigned to them receive automatic pointer support. The DESQview Field Manager, which provides field-editing and navigation support, handles the mouse automatically for these windows. Pointer objects must be used only when a program wants to monitor the mouse directly.

Table 8 lists DESQview API calls associated with pointer objects. Programs use these calls to track mouse movement across multiple windows, manipulate motion-scaling parameters, and tell DESQview whether pointer signals are to be passed to the application when it runs in background. When the user clicks a pointing device in a window that does not have a pointer object, DESQview brings that window and its application to the foreground and gives it the keyboard focus (attaches its keyboard object to the physical keyboard). If the application already is in the foreground, DESQview ignores the pointer input.

DESQview *mailbox objects* provide the intertask communication facility used by DESQview-specific tasks to exchange messages. Messages written to a mailbox object are written into a queue, where they remain until read by the mailbox owner. Applications can assign names to mailbox objects. Other tasks can locate the mailbox by using the name in an API call to ask DESQview for the named mailbox's handle. API calls associated with mailbox objects appear in table 9.

AST makes the fastest and highest-quality desktop computers in the business world. One of them is right for you. Whether you need a personal computer for general office work, engineering, desktop publishing, financial analysis or running your business at home, you can count on AST to fit your desktop size, your budget and your need for ultimate speed.

INFO WORLD REPORT CARD

AST Premium/386	COMPAQ DESKPRO 386® 20/0	IBM® PS/2™ Model 80-111
8.0	7.5	6.5

Final Scores • 20 MHz 386-Based Computers May 2, 1988

Our Newest Wonders. If you want extra performance and high quality without spending a lot of money, try our newest computers — the AST Premium® 386/16 and the AST Bravo/286. Our cache-based AST Premium 386/16 makes 386™-CPU computing available to even the most cost-conscious budget. And the AST Bravo/286 is all the AT®-compatible power you need for small or large businesses, home offices, or local area networks.

Our Most Powerful Wonders. For high-speed CAD/CAM/CAE, multitasking, multiuser environments and LAN file service, choose AST's top performing systems. The 25 MHz AST Premium 386/25 and 20 MHz AST Premium/386C bring the highest performance to your sophisticated 386-CPU based applications.

Our Most Versatile Wonder. If you have to choose one computer that satisfies the broadest range of needs, let it be the AST Premium/286. Perfect for flying through word processing, large spreadsheets and even technical applications, it's the industry's award-winner for 286 performance and value.

AST Premium/286 ★★★★ Top Rated '286 PC —PC Digest™ May 1988

Our Smallest Wonders. When your desktop space is limited, but your appetite for speed and power isn't, the AST Premium Workstation/386SX and the AST Premium Workstation/286 offer test-proven compatibility you can rely on. These sleek, small-sized wonders are the quality answer to cost-effective, high-performance desktop computing.

LAN MAGAZINE PC AWARDS

AST Service, Support And Reliability — The Eighth Wonder. The AST logo means quality products and service. In fact, PC Week recently named AST first in technical support, over Compaq® and IBM®*

For the products and service that will make you the next wonder of the world, ask for AST Computers. For more information, call **(714) 863-0181** and ask for **operator BB15**, use our Bulletin Board Service number **(714) 852-1872**, or fill out the coupon.

☐ Please send me information on AST computers. PCTJ 4/89
☐ Please have an AST representative call me.
I am ☐ an end user ☐ a reseller.
Name ______________________
Title ______________________
Company ______________________
Address ______________________
City/State/Zip ______________________
Phone ______________________
AST Research, Inc. 2121 Alton, Irvine, CA 92714-4992. Attn: M.C.

AST® RESEARCH INC.
Times Have Changed.

*Source: PC Week, Nov. 14, 1988.

AST markets products worldwide — in Europe and the Middle East call 44 1 568 4350; in Japan call 81 3 818 0710; in the Far East call our Hong Kong office 852 5 806 4333; in Canada call 416 826-7514.

CIRCLE NO. 164 ON READER SERVICE CARD

TABLE 6: *Panel APIs*

FUNCTION	DESCRIPTION
pan_apply	Display a named panel and prepare for input
pan_close	Close a panel file
pan_dir	Get list of panels in the panel file
pan_free	Free a panel object
pan_new	Create a panel object
pan_open	Open a panel file
pan_sizeof	Get number of panels in the file
pan_status	Get status of last pan_open or pan_apply

A DESQview panel is a specialized window containing the controls for user interactions, such as menus, dialog boxes, or help screens. Applications can use panels without knowing their format or contents, so the user interface can be changed readily.

DESQview creates and opens a default mailbox each time it creates a new task. Applications can request Window Manager notification when the user manipulates keyboard focus, moves, or resizes a window. DESQview sends all Window Manager notification messages to the default mailbox unless the application specifies otherwise.

Programs can send mailbox messages either by value or reference. When programs send mailbox messages by value, DESQview copies the message contents into a destination queue along with the sender's task handle and an optional status byte. The receiver acquires a pointer to the copied data at read time.

When an application sends a message by reference, DESQview does not copy the data, but instead gives the receiving task a pointer to them in the sender's memory. For two tasks to access the same memory, they must be within the same process or have shared memory defined in their .DVP files.

DESQview mailbox objects are similar to OS/2 queues, but OS/2 writes queue data only by reference, not by value. OS/2 allows the sender to assign one of 16 priorities to the queue messages, and allows the queue owner (reader) to select first-in/first-out (FIFO), last-in/first-out (LIFO), or priority ordering of messages.

In place of semaphores (not provided by the DESQview environment), applications can lock a mailbox to serialize access from several processes to a common resource. Cooperating programs must be written with knowledge of the mailbox name associated with a resource. A program wishing to use the resource locks the mailbox, uses the resource, then unlocks the mailbox. While the mailbox is locked, DESQview suspends any other process attempting to open it.

DESQview-specific programs use *timer objects* to invoke and monitor timers set for specified-interval or time-of-day values. Timer granularity is a true 1/100 of a second, obtained by reprogramming the clock chip hardware. Table 10 lists DESQview API calls associated with timer objects.

Programs can declare multiple timers, which can run concurrently, and can use the API calls either to monitor the progress of a timer or to suspend execution until it expires. Cooperating tasks can write timer handles to each other's objectqs to coordinate events, much as OS/2 processes exchange signal events.

A STRETCH OF MEMORY

The DESQview programming environment is more complex than the environment under DOS. Outside DESQview, available memory stretches from the top of any terminate-and-stay-resident (TSR) programs loaded above DOS to the video buffer at segment A000H. In a single-tasking environment, a program can use all of this area for whatever purpose it chooses because it is the only process executing.

DESQview must manage memory so multiple programs can be loaded concurrently; each is given as much memory as it needs without affecting others. DESQview manages memory according to the type of memory available at runtime; it maximizes use of expanded memory that conforms to version 3.2 of the AST Research/Quadram/Ashton-Tate enhanced expanded memory specification (EEMS) or version 4.0 of the Lotus/Intel/Microsoft expanded memory specification (EMS). On 386 systems, when run with Quarterdeck's QEMM-386 memory manager, DESQview runs each task in a separate virtual-8086 (V86) partition. QEMM-386 and DESQview are bundled as DESQview 386, or QEMM-386 is available separately.

DESQview uses expanded memory for more than data storage if the area controlled by DOS (below 640KB) can contain mappable page frames. This capability is provided by all versions of EEMS memory boards, EMS boards built to version 4 specifications, and

TABLE 7: *Keyboard APIs*

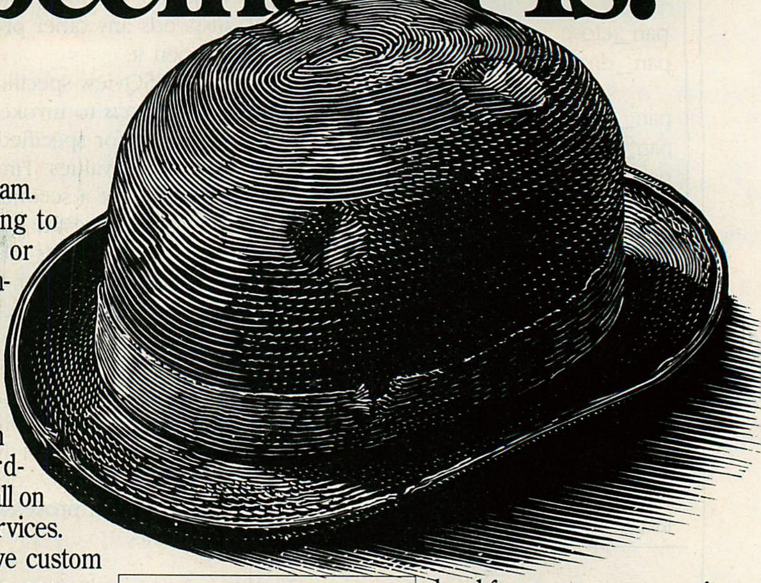
FUNCTION	DESCRIPTION
api_pushkey	Push key into input stream
key_addto	Set keyboard behavior flags
key_close	Disconnect keyboard from its window
key_erase	Discard pending keyboard input
key_free	Free a keyboard object
key_getc	Wait for next key (keystroke mode)
key_me	Get current task's keyboard handle
key_new	Create a new keyboard object
key_of	Get handle of a given task's keyboard
key_open	Attach keyboard to a given window
key_read	Read input from keyboard
key_sizeof	Get count of keyboard messages pending
key_status	Get status of last keyboard message
key_subfrom	Clear keyboard behavior flags
key_write	Write data to keyboard

Each DESQview window gets its own logical keyboard; each keyboard, its own type-ahead buffer. Applications should not poll the keyboard, but should wait until the keyboard inserts a message into the task's objectq.

386 systems running an EMS-compatible memory manager such as QEMM-386 or Qualitas Software's 386-to-the-Max. In these cases, DESQview allocates an expanded memory block of up to 400KB to each task, and performs task switches almost instantly by mapping a new task's block into the DOS address space. (For a full description of expanded memory, see "EMS 4.0 Pulls Together," Ted Mirecki, July 1988, p. 72.)

With EMS version 3.2 or earlier, DESQview can use expanded memory only for storing data or for a RAM disk, not for executing programs. Those versions provide a single page frame of 64KB, an area too small to accommodate most programs. Copying program code from conventional to expanded memory through the page frame offers no advantage over swapping to a RAM disk in expanded or extended memory.

Whatever happened to emulator-specific APIs?



Linking PCs to mainframes may be old hat. But to do the job properly, you need to build on top of your emulator, creating a custom application that's both bullet-proof and idiot-proof.

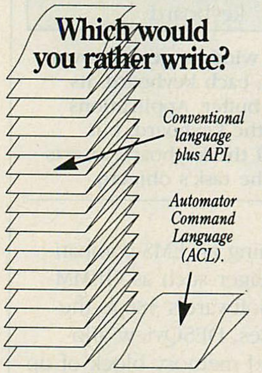
Many developers are still doing it the hard way. Using emulator-specific APIs, conventional languages and months of hard labor.

But instead of months, you can now do it in days, or even—literally—hours.

With Automator, from Direct Technology. A unique, award-winning development system, designed to tackle exactly this kind of problem.

A brilliant new approach.

Automator supports a comprehensive high-level language, ACL, tailored for the intelligent automation of PC-to-mainframe links.



ACL code gives you high-level control of your emulator and DOS applications. All the functionality you need is built-in. Your code is shorter, clearer, easier to write and easier to maintain.

ACL programs run resident, seizing control of the PC and any foreground application whenever necessary.

ACL gives you the kind of power that you usually have to create for yourself. Such as event-handling, task scheduling and concurrency. And the remarkable ability to simulate, under program control, *anything* a human operator can do.

Yet ACL has all the meat you need to actually write your application; from disk file handling and low-level interfacing, to window and menu support.

The universal scripting language.

Pull data off a mainframe, shift it into Lotus and print a graph—all under control of your ACL program.

Without having to adapt mainframe or PC software. Without getting your hands dirty driving APIs.

Automator applications can address the hardware directly or call on BIOS and DOS services.

They can drive custom software written in conventional languages. Or get any standard PC application to do their work for them.

Automator transcends any one PC application and the specifics of particular APIs. So it can integrate any PC applications, whether they have APIs or not.

Giving you a single, generic standard for automation and integration. And high-level code that is easily portable, easy to adapt and easy to maintain.

Not Version One.

With Automator, you're developing your own software, not beta-testing somebody else's.

Automator has been the secret behind successful comms projects at over 800 major corporations worldwide since 1984.

And we're committed to keeping the product up-to-date with advancing technology.

So you can be sure that Automator will be working as hard for you tomorrow as it is today...

The Automator environment.

- Memory-resident text editor, runtime interpreter, compiler, program generator, interactive window and menu designer.
- Low memory-overhead runtimes.
- High-level procedural language similar to a modern structured BASIC.
- Event-driven task scheduler.
- Simulate keystrokes, read and interpret data directly from screen.
- Disk file support from within ACL.
- Built-in windowing and menu support.
- Plus... named procedure calls, program and variable chaining, numeric and string arrays, math operators, PEEK, POKE, IN, OUT... and much more.

Slaughter development time.

An Automator developer is an order of magnitude more productive than the same person working with an API and a language such as C, BASIC or Assembler.

Chances are, you could get your next PC-to-mainframe project to prototype in less time than it takes to read our comprehensive Technical Overview.

For your free copy, clip the coupon or call 1-800-992-9979; in New York City, call (212) 475-2747.

YES! I'd like to see how Automator can slaughter PC-to-mainframe development time. PCT4

☐ Rush me a FREE copy of your Technical Overview.
☐ Call me soon to arrange a demonstration.

Name ....
Title ....
Company ....
Address ....
.... Zip ....
Telephone ....

Return coupon to:
Direct Technology, Inc.
10 East 21st Street, Suite 1204/5,
New York, NY 10010.

AUTOMATOR
From Direct Technology.

FOR THE NAME OF YOUR NEAREST DEALER CALL 1-800-992-9979.

Automator is compatible with IBM PC, XT, AT and 100% compatibles, and PS/2 model 30, 50, 60, 80.
Most communications products, including the leading 5250, 3270 and VT100 emulators from AST, DCA (IRMA), IBM (except Workstation Program 1.0 and 1.1), Rabbit, IDEA, ITT, CXi, Techland (Blue Lynx), INS and Honeywell VIP.
Most popular networks, including Novell, Gnet, IBM Token-Ring, IBM PC Net, Banyan, 3Com and Torus.
Direct Technology, Inc. 10 East 21st Street, Suite 1204/5, New York, NY 10010. Telephone (212) 475-2747. Facsimile (212) 529-4941. Direct Technology acknowledges all trademarks used in this advertisement.

CIRCLE NO. 124 ON READER SERVICE CARD

TABLE 8: ***Pointer-related APIs***

FUNCTION	DESCRIPTION
api_kmouse	Turn keyboard mouse on and off
fld_point	Move pointer to a given position in a field
ptr_addto	Set pointer-control flags
ptr_close	Close a pointer object
ptr_erase	Erase pending pointer messages
ptr_free	Free a pointer object
ptr_getscale	Get current scaling factors
ptr_new	Create a new pointer object
ptr_open	Open pointer and assign to a window
ptr_read	Wait for next pointer message
ptr_setscale	Set current scaling factors
ptr_sizeof	Get count of messages pending
ptr_status	Get button status from last message received
ptr_subfrom	Clear pointer control flags
ptr_write	Move the pointer to a given position
qry_kmouse	Inquire if using a keyboard mouse
win_point	Jump mouse pointer to logical cursor position

The pointer interface can handle devices such as mice, joysticks, trackballs, and optical pens. An application should wait for notification of pointer events via the objectq.

TABLE 9: ***Mailbox-related APIs***

FUNCTION	DESCRIPTION
mal_addr	Return sender of last message
mal_addto	Send a message by value with given status
mal_close	Close a mailbox
mal_erase	Erase all pending messages
mal_find	Find a mailbox by name
mal_free	Free a mailbox object
mal_lock	Lock access to a resource
mal_me	Get handle of current task's mailbox
mal_name	Assign a global name to a mailbox
mal_new	Create a new mailbox
mal_of	Get handle of a given task's mailbox
mal_open	Open a mailbox
mal_read	Wait for next message
mal_sizeof	Get count of messages pending
mal_status	Get status of last message received
mal_subfrom	Send message by reference with given status
mal_unlock	Unlock access to a resource
mal_write	Send a message by value with status zero

Mailboxes provide interprocess communications. They act like OS/2 queues when passing data by reference, and they act like OS/2 or Unix pipes when passing data by value.

Whether mapping processes into disjointed EMS blocks or stacking them in physical DOS memory, DESQview ensures that no process is aware of the memory occupied by any other process. When a program is executing, other processes either are mapped out of the system address space (if they reside in expanded memory) or reside in memory marked by DOS as unavailable. As with any DOS-based system, this precaution does not prevent a runaway process from corrupting another process by overwriting memory outside its allocation. However, on a 386 system with QEMM-386, the user installing an application can invoke the V86 protection mechanism, which prevents that program from accessing memory outside its own address space. The developer or installer also can give an application access to a pool of shared system memory.

DOS loads DESQview as it would any other program, immediately above the device drivers and TSR programs. The amount of DESQview memory overhead varies depending on the particular system configuration. On a system that does not have EEMS or EMS 4.0 memory, DESQview's memory overhead can be as high as 160KB. On an 80386-based system using QEMM-386, DESQview uses as little as 7KB of the memory residing below 640KB, and places the remainder of itself in expanded memory.

DESQview object structures for currently executing tasks reside in a conventional-memory area (below 640KB) called *common memory.* DESQview allocates this area immediately above itself. By default, it allocates 17KB, but the user can change the size by running the DESQview setup process. Environments that execute more than nine processes concurrently may need larger common memory.

DESQview classifies all remaining memory between common memory and the video buffers as *conventional memory.* A process must reside in conventional memory when it is executing; the advantage of EEMS or EMS 4.0 is that DESQview can map one of several processes into conventional memory at each time slice. The size of conventional memory determines the size of the largest memory block that DESQview can allocate for a single process, and therefore the largest program that can execute.

When DESQview first starts, it allocates a zero-length *shared memory pool* immediately above common memory. As it loads processes that request access to shared memory, this pool grows toward the top of memory. All processes that use shared memory have access to each other's window buffers and mailbox messages, which allows different processes to communicate data by reference. Without the shared-memory pool, no guarantee exists that a process's system memory is addressable when another process attempts to access it.

DESQview loads programs into the upper portion of conventional memory, loading subsequent processes underneath. Once conventional memory fills, DESQview maps a new block of expanded memory into the DOS space and loads more processes. When expanded memory is full, DESQview frees space for more processes by swapping processes out to disk. When installing an application to run under DESQview, the user can specify if the program can be swapped out. Communications programs should not be swapped because they must receive incoming data.

For each process, DESQview allocates *process memory* to accommodate the program's code and data space, the script buffers, DESQview-specific context information, and a process-specific system-memory pool. DESQview calculates the amount of process memory to allocate from fields entered by the user in the .DVP file when installing the application.

The *system memory pool* holds the process's logical-window buffers, mailbox-message buffers, panel directories, and applied panels. System memory is private to a process by default, but a user can request, by an entry in the .DVP file, that it go into shared memory. This is a repository for

code or data common to several processes which enables cooperating processes to communicate.

DESQview versions 2.20 and later support shared code that is functionally equivalent to OS/2 dynamic-link libraries. When DESQview starts a new process, it checks the .DVP file for shared programs. If they are named in the .DVP, it checks to see if the shared programs are already loaded. If they are not loaded, it loads them into the shared-memory pool. Shared programs are constructed like .COM files, but their entry point is at offset 0H, not 100H, and they are loaded without a program-segment prefix (PSP).

DESQview calls each shared program (at offset 0H) before starting the first process that named it in its .DVP file, and again after the process terminates. The shared program then can initialize a software-interrupt vector or other mechanism that the calling process can use to invoke procedures in the shared library.

Multiple processes that name a shared program interact with the same physical copy of that program. DESQview tracks how many processes are sharing a program and frees the shared code only when the last calling process terminates.

Although each program running under DESQview appears to have its own contiguous memory and to be the only program running under DOS, many programs may be executing concurrently. DESQview's efficient context-switching mechanism, especially when augmented by the ability to map expanded memory into the conventional address space, is at the core of this environment's power. Like OS/2, DESQview allows a process to spawn additional tasks within its own process memory and spawn independent new processes. DESQview maintains the integrity of the task and process environment by saving context-sensitive information. For each process, DESQview also saves many DOS variables, including the current drive, current directories for each drive, disk-transfer address, control break, and verify settings.

Like OS/2, DESQview uses a preemptive multitasking protocol wherein the operating system, not the active task, decides when to suspend one task and execute another. In the alternative method, cooperative multitasking as used by Microsoft Windows, a task remains active until it voluntarily yields control of the system. The preemptive method ensures that no task monopolizes system resources and that the system can quickly invoke tasks that respond to asynchronous events such as input at a communications port.

TABLE 10: *Timer APIs*

FUNCTION	DESCRIPTION
tim_addto	Start a timer for a given interval
tim_close	Close a timer object
tim_erase	Stop a running timer
tim_free	Free a timer object
tim_len	Get time remaining until timer expires
tim_new	Create a new timer object
tim_open	Open a timer object
tim_read	Wait for the timer to expire
tim_sizeof	Get time since timer started running
tim_status	Determine if a timer is running
tim_write	Start a timer for a given time of day

Timer objects provide both elapsed-time and time-of-day services. DESQview reprograms the clock hardware for a resolution of 10 milliseconds.

Bank-switched memory significantly enhances DESQview's ability to provide preemptive multitasking, because a context switch involves merely mapping in a new set of expanded-memory pages instead of copying the memory contents of the incoming task from disk or extended memory. With expanded memory, context-switching between tasks that occupy all of conventional memory is barely longer than switching between smaller coresident tasks that share the conventional memory space. Still, in high-speed communications even the slight delay caused by mapping is a potential concern. If the communications process is mapped out when it needs to resume execution, the normal delay due to the overhead of a context switch is extended by the call to the Expanded Memory Manager for restoring the process to the DOS address space. The additional time usually does not affect high-speed communications unless DESQview is concurrently executing nine or more non-DESQview-specific processes.

DESQview's presence enhances performance for applications that do direct memory access (DMA) operations into or out of expanded memory. The purpose of DMA is to perform memory transfers without the intervention of the CPU, allowing the CPU to perform other processing in the meantime. If the DMA source or destination is residing in expanded memory, the developer has to ensure that other executing processes do not change the EMS mapping.

DESQview prevents such failures by intercepting DOS and BIOS calls that could do a DMA operation. For all block-mode devices, such as disk drives, DESQview redirects the DMA operation to or from a memory location that remains resident even if the parent process is mapped out. Once the transfer completes and the transferring process is in conventional memory, DESQview copies the result of the DMA operation to its destination.

Another advantage of EEMS and EMS 4.0 is DESQview's ability to execute portions of its own code in expanded memory, providing a larger memory space for applications. Processes larger than 400KB will run under DESQview only in the presence of EEMS or EMS 4.0 memory. Developers whose applications must run on all systems must limit individual process memory requirements to about 300KB.

Besides managing conventional and expanded memory for real-mode applications, DESQview 386 manages extended memory for protected-mode applications running under the control of a DOS extender (see "Leaving 640KB Behind," William E. Brooks, this issue, p. 38). This is necessary because DESQview 386 runs as a control program at protection privilege level 0, while the real-mode applications under its control run in V86 mode at privilege level 3. Because the 386 protection mechanism prevents level 3 programs from switching to protected mode, a DOS extender started in V86 mode cannot by itself gain access to extended memory.

Quarterdeck and Phar Lap (the developer of 386/DOS-Extender) developed a protocol called the Virtual Control Program Interface (VCPI) by which a DOS extender can request a privileged control program, such as DESQview 386, to perform protected-mode services, such as allocating extended memory and executing processes in protected mode. One or more VCPI-compatible protected-mode processes can execute under DESQview 386 at the same time as several real-mode processes.

TO INTERRUPT OR NOT?

Developers must adopt very specific programming techniques to ensure proper behavior and adequate performance in a multitasking environment.

Because tasks are suspended from time to time, all timing loops should use DESQview timer objects, ask DOS, or search the BIOS area (address 40:6CH) for the amount of time elapsed. Because of varying processor speeds, using program loops for timing is unreliable even under DOS. Program loops are even less reliable under DESQview where, depending on the current mix of executing programs, a task can get widely varying percentages of processor time. Counting timer ticks under DESQview fails because, in a multitasking environment, the program gets the timer interrupt only during its time slice.

In a preemptive multitasking environment, tasks are subject to interruption at any time. Therefore, programs should avoid time-critical regions of code that depend on uninterrupted execution. When such sections are unavoidable, developers should prevent DESQview from interfering by marking that area of code as a critical region (with calls to the api_beginc and api_endc functions), and making it short. This prevents time-slice interrupts, but not hardware interrupts. Disabling hardware interrupts can prevent concurrently executing time-dependent tasks from getting the time to run, causing them to fail.

Disabling interrupts is acceptable under DESQview only for very short periods, say for 50 or fewer machine instructions. If a process needs a longer time-critical period, the developer must warn users that high-speed communications executing concurrently with the application may fail. Programs should not access the 8259A or equivalent interrupt-controller chip to mask interrupts selectively because the environment for concurrently executing processes may be corrupted if a program terminates without restoring the state of the interrupt controller. Use of the CLI instruction can mask interrupts without corruption.

DESQview provides its own ANSI interpreter, DVANSI.COM, because the ANSI.SYS driver that comes with DOS can handle only one program at a time. DVANSI.COM is a TSR that must be loaded into each DESQview window that requires ANSI support. Only one task within a given process can use DVANSI.COM.

Because neither DOS, BIOS, nor DESQview APIs provide useful graphics-output services, developers of graphics applications must write code that accesses screen memory directly. Most users do not want to run graphics programs in background unless they are sending output to a hard-copy device. To allow background execution, graphics programs should switch to text mode while doing heavy non-video processing such as calculating printer or plotter output.

DESQview supports only IBM-defined video adapters (MDA, CGA, EGA, MCGA, VGA), Hercules, and a few others. Developers should avoid using modes or features incompatible with these environments or DESQview will not properly save and restore the application's video state when it executes concurrently with other programs.

Developers creating EGA-based applications should note that EGA adapters have several write-only registers whose contents are not available to DESQview. DESQview overlays EGA windows only when the program that owns the window uses DOS or BIOS to test or wait for input, invokes DOS interrupts 21H (DOS call) or 28H (DOS idle), or calls the api_pause function to give up its time slice. Programs must not assume that the EGA write-only register states are preserved across these calls. However, because VGA and MCGA have readable registers even in EGA mode, DESQview can properly save and restore video states on systems without special action by the program.

If a DESQview object is deallocated or its task terminates, the handle used only milliseconds ago is no longer valid.

DESQview versions 2.20 and later do not prohibit use of software interrupts. Applications executing under earlier versions, however, cannot use interrupts 50H to 57H, 6AH to 6FH, and 78H to 7FH. These are reserved for DESQview's use. Three other interrupts, 15H (many BIOS functions), 1BH (keyboard break), and 1CH (the timer) behave differently under DESQview than under DOS. Developers who plan to hook these interrupts should review chapter 17 of the *DESQview API Reference Manual*.

DESQview fully supports use of the 8087, 80287, and 80387 math coprocessors, and saves and restores coprocessor states across context switches. It also supports hardware-interrupt processing at two priority levels. First-level interrupt handlers, which receive control via the hardware interrupt, are responsible for hardware-specific manipulation to process and clear the interrupt. Second-level handlers receive control from first-level handlers and communicate with the DESQview environment. DESQview does not allow first-level handlers to issue DESQview API calls other than the api_setbit call, which schedules a second-level handler. Interrupt handlers that need to send a message to a DESQview object, start up another task, or otherwise interact with the operating environment must first schedule a second-level handler.

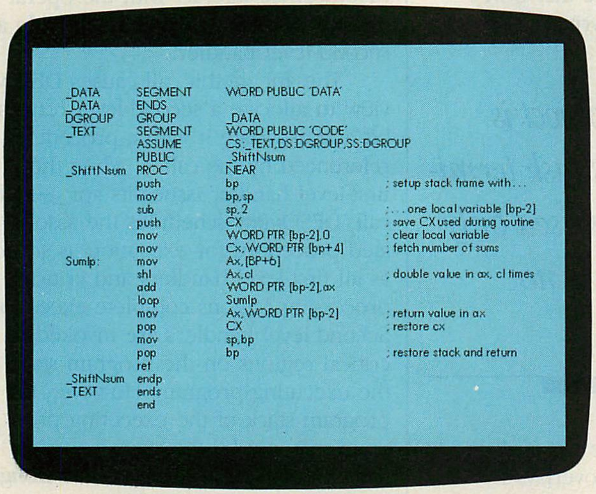
The api_getbit call causes DESQview to allocate a second-level request bit and associate it with a procedure referenced by the caller. When the first-level handler issues its api_setbit call, DESQview schedules the associated procedure for execution as soon as all first-level handlers and critical processing regions complete execution. Second-level handlers are invoked as critical regions on the program stack of the executing program. However, the program stack of the executing program may not be the stack to which the second-level handler code belongs. While second-level handlers can issue API calls, they must avoid calls that depend on the identity of the current task, and they should make no assumptions regarding the size or content of the program stack.

DO'S AND DON'TS

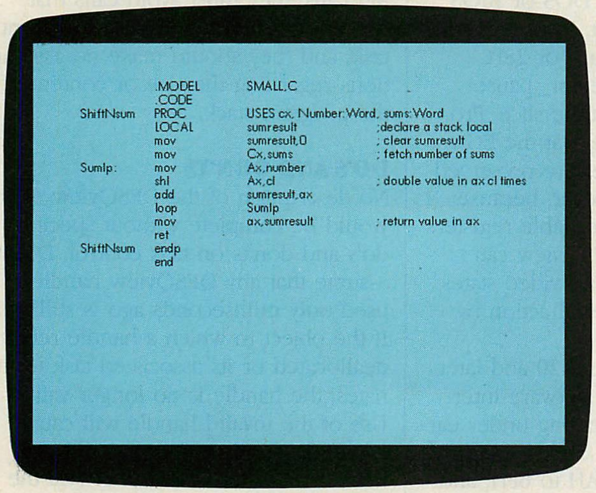
No description of the DESQview APIs would be complete without specific do's and don'ts on task control. Do not assume that any DESQview handle used only milliseconds ago is still valid. If the object to which a handle refers is deallocated or its associated task terminates, the handle is no longer valid. Use of the invalid handle will cause DESQview to terminate the task that issued the call. Always verify (via the api_isobj call) the validity of any handle. To ensure that the object does not disappear between the call to api_isobj and the use of the handle in another API call, the two calls should be within a critical section delimited by calls to api_beginc and api_endc.

DESQview reuses task handles—it can therefore start a new process with the same task handle as that of the no-longer-executing process being monitored. For applications that consist of

Microsoft MASM 5.1 gives you two things you've never had in a macro assembler. OS/2 and spare time.



The old way: slow, cumbersome coding.



The new way: time off for good behavior.

As a professional programmer you know how fast MASM subroutines make your programs run. But you've also had to pay the price of cumbersome coding.

With Microsoft® Macro Assembler version 5.1, you get ease *and* speed. Starting with our *Mixed Language Programming Guide* that teaches you how to call MASM subroutines from your high-level programs. To the PROC directive that makes it as easy to pass parameters to an assembler subroutine as it is in high-level languages. Plus you get our easy-to-use "fill-in-the-blanks" template programs.

In addition to MS-DOS® support, MASM 5.1 has full OS/2 system support that lets you do things like break the 640K barrier, create multithreaded applications and Dynamic Link Libraries. And you get a complete set of high-octane development tools that lets you work faster under both environments. As well as the reconfigurable Microsoft Editor, a high-speed linker and incremental linker for OS/2. And the renowned Microsoft CodeView® window-oriented source-level debugger that lets you blaze through debugging.

For the details, check the techbox. For more information, call (800) 541-1261. And learn how today's Microsoft MASM is so fast and easy it comes with the following offer.

The night off.

Microsoft Macro Assembler Version 5.1 for OS/2 and MS-DOS

Mixed-Language Programming Support and Documentation
- Mixed-Language Programming Guide with step-by-step examples.
- MASM templates for interfacing to BASIC, C, FORTRAN, and Pascal.
- Sample macros for interfacing for DOS and OS/2 systems.
- Simplified segment directives make writing MASM subroutines easy.
- Comprehensive instruction set *reference* with examples.
- Programmer's Guide—complete guide to MASM features and instruction set.

Macro Assembler for OS/2 and MS-DOS
- Full OS/2 support to break the 640K barrier.
- Supports the 80386 and 80387 instruction set.
- Assembles 25-40% faster than MASM 4.0.
- Have labels local to a procedure.
- Declare stack based local variables within a procedure.
- OS/2 systems incremental linker—up to 20 times faster than a full link.

Microsoft CodeView Window-Oriented Debugger and Microsoft Editor
- Full OS/2 systems support.
- Debug MASM code using original source code with your comments.
- Interactively view structures and chase linked lists.
- Take advantage of the 80386.
- Set dynamic breakpoints, watch variables, memory, registers and flags.
- OS/2 and MS-DOS reconfigurable programmer's editor.

Microsoft

Making it all make sense.

multiple processes, where one process monitors the continuing execution of one or more other processes in the application set, do not assume the continued validity of the task handle means that the task being monitored is executing. DESQview can abort or terminate a process between monitoring tests, and can reassign the handle to an unrelated process.

Developers who need to monitor a process should assign a name to the default mailbox that DESQview creates for the process to be monitored. The monitoring task should use the mailbox name to validate the existence of the mailbox object assigned to the monitored task. The existence of the named mailbox implies the existence of the task.

As in any multitasking environment, proper behavior of concurrently executing tasks maximizes overall performance. Although DESQview's preemptive multitasking prevents a task from monopolizing the system, a poorly designed application can have a negative impact on the performance of other applications executing concurrently. The following techniques maximize performance of DESQview-specific applications:

- To maximize time available to concurrently executing programs, use the DESQview API's objectq to suspend tasks and reawaken them automatically when input becomes available. Do not wait for input in active polling loops.
- If you are not using the objectq, use the api_pause call to give up your time slice periodically.
- Use DESQview keyboard objects to process user input; do not poll the keyboard buffer directly.
- If you cannot use a keyboard object because you are using a commercial keyboard macro processor, issue the api_pause call between the processing of each keystroke.

Finally, no DESQview developer should be without the DESQview API Debugger. Although many other debuggers are on the market to debug individual DOS programs, DESQview-specific applications are made up of multiple programs. When debugging DESQview-specific applications, developers probably want to see how all tasks communicate with their DESQview objects. The DESQview API Debugger allows them to debug any number of processes concurrently. Like most debuggers, the API Debugger traces conditions and sets breakpoints. The biggest plus, however, is the API Debugger's ability to single-step through all DESQview API calls regardless of the process issuing the call.

OLD DOS PROGRAMS

Using all seven DESQview objects properly in developing applications ensures maximum performance efficiency in all DESQview environments. What about the performance of old DOS applications that you want to integrate with your new DESQview-specific programs? If you have access to source code, the following minimum subset of DESQview API calls can modify an application's behavior under DESQview without sacrificing its performance under DOS:

api_beginc	- begin critical region
api_endc	- end critical region
api_exit	- exit API
api_init	- initialize API if DESQview is present
api_pause	- give other tasks a chance to run
api_shadow	- return a logical window buffer and start shadowing

Use a global variable to indicate whether a program is executing under DOS or DESQview. To set the variable, issue the api_init call, which returns a value that indicates DESQview's presence or absence.

If an old application writes directly to video memory, modify the code that determines the current video-memory address to pass that address to DESQview via the api_shadow call. The api_shadow call returns the address of a DESQview memory space to use instead of the original video-memory address. DESQview then monitors that video address and automatically updates the physical screen to reflect any changes that are made to the logical video buffer.

If the old program uses a common subroutine to receive keyboard input, simply insert the api_pause call between tests for keyboard activity. If the old program uses scattered individual calls to library functions, place an api_pause call once per major program loop to ensure that other tasks are given a chance to run.

With DESQview APIs, developers can significantly shorten development times and provide a consistent and robust user interface.

NO MORE MAKING DO

DESQview's ability to take full advantage of bank-switched systems ensures long life of DESQview-specific applications as users migrate to larger and more powerful systems. Developers, taking full advantage of DESQview APIs, can significantly shorten development times and provide a consistent and robust user interface by making extensive use of DESQview panel objects and the DESQview Field Manager facility. Knowledge and use of the DESQview Panel Design Tool provide the developer with the ability to customize screens and easily create foreign-language versions of an application for international use without the need to change application code.

The DESQview API Debugger significantly reduces the time it takes to debug programs in a multitasking environment. Developers should use 386-based systems with QEMM-386 for debugging large applications to take advantage of V86 mode.

The weakest link in the DESQview API tools is the documentation of the many API calls. The documentation should define separate objects for such items as tasks and menus (separate from windows or panels), and it should categorize the calls by the object being manipulated.

DESQview's preemptive multitasking and the similarity between its APIs and OS/2 make it an ideal platform for developing applications that must execute on systems without enough memory or processor power to support OS/2. As a multitasking environment, it offers many of the advantages of OS/2 with lower overhead and lower hardware requirements, and two advantages over OS/2—the ability to execute on the millions of 8088-based systems and to run multiple existing DOS programs simultaneously.

Quarterdeck Office Systems
150 Pico Blvd.
Santa Monica, CA 90405
213/392-9851
DESQview API Toolkit: $500
CIRCLE 343 ON READER SERVICE CARD

Frederick J. Hitt is a senior consultant for micro development at General Electric Information Services (GEIS). He designed GEIS's Concurrent Operating Program Environment (CORE), a multitasking developer platform using DESQview's API services.

A Safety Net for LAN Data

Disaster recovery for large LANs requires planning, careful management, and the right equipment. As LANs have grown, the methods and tools for managing tape backups also have matured.

Backup is the first line of defense, a cornerstone of any disaster plan. Minicomputer and mainframe systems managers learned how important reliable, complete backups are through long, hard experience. So why do many LAN managers wait until their first data disaster to face the mundane realities of backup?

Increasing numbers of local area networks (LANs) support hundreds of users and hundreds, even thousands, of megabytes of critical corporate data sitting on vulnerable hard disks. Many methods are available for safeguarding the data on a system. Ensuring reliable, clean power; paying close attention to system cabling; providing emergency power for critical system components—all contribute to system reliability and protect data, but even the most carefully planned and managed computer system can have data disasters.

PC Tech Journal here considers strategies for planning and executing backup procedures, along with some of the hardware available to accomplish the task. Included in this evaluation are tape drives from Advanced Digital Information Corporation (ADIC), CORE International, Emerald Systems Corporation, Maynard Electronics, and Mountain Computer Inc. The drives reviewed can be configured for storage capacities of 250MB to 2.2GB. The CORE drive accommodates "only" 150MB at this point; it is included because the drives will have 250MB capacity with the introduction of DC1000 tape.

Backing up your LAN protects against failure or destruction of a system component or accidental deletion of files, but it is also useful for archiving the storage of files and for transferring data to other sites. Restoring all data on the network in the event of a major system failure is a critical requirement for a backup device; yet, complete loss of all data on a disk is relatively rare. Increasingly, large disks used on LANs have mean-time-between-failure (MTBF) ratings of 50,000 hours of power-on time or about six years of continuous running.

Using tape to back up these reliable hard disks may seem a paradox. Tape and tape drives are inherently less reliable than the drives they are meant to protect. Tape is a flimsy medium that is exposed to dust, hair, and lint floating around in the environment. Tape heads drag in physical contact with the tape. Chances are that tape drives will fail at several times the rate of hard disks. If, however, you want to keep multiple copies of complete backups at alternate sites, ship 100MB of

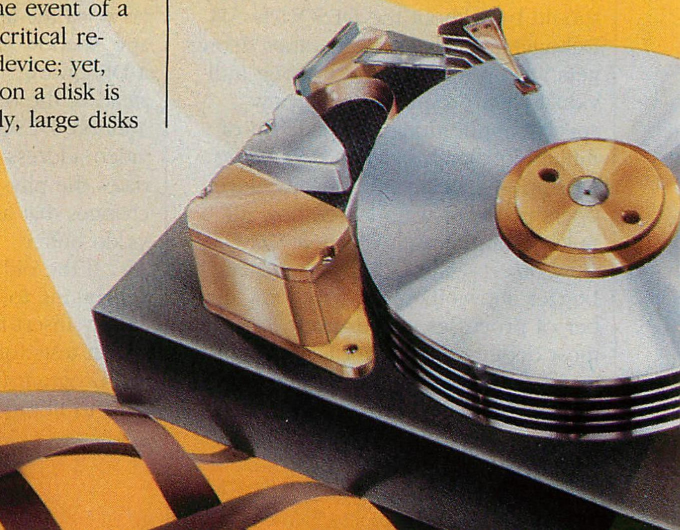
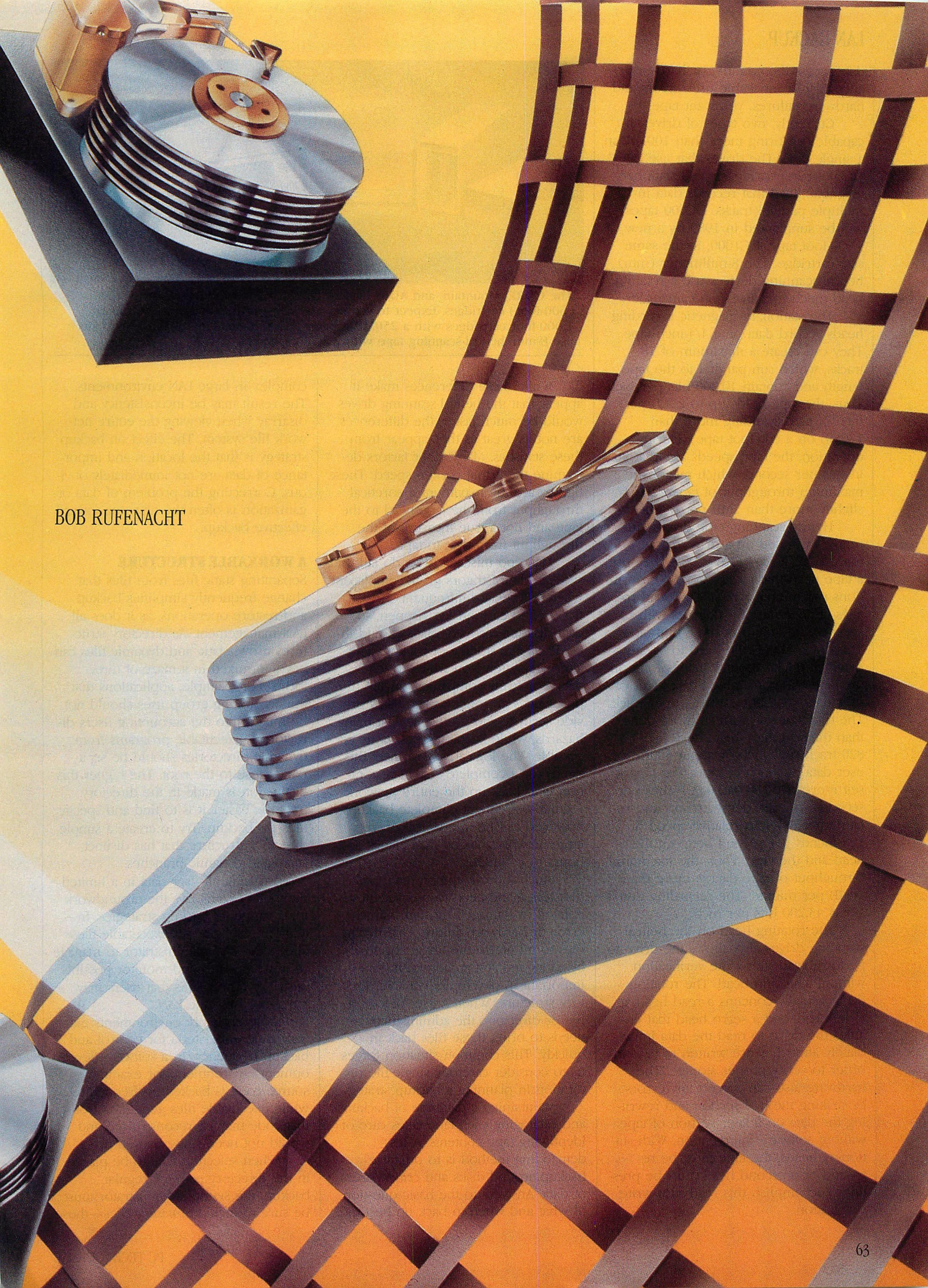


ILLUSTRATION • FRANK RILEY



BOB RUFENACHT

data across the country, or have insurance against inevitable user errors and hardware failures, you want tape.

Currently, two types of drives are capable of storing more than 100MB on a single tape. The drives that use DC600-style cartridges use a stationary magnetic head that records data in multiple parallel tracks. DC600 tapes will be supplanted in 1989 by a new 1,000-foot tape, DC1000, in the same size cartridge. The 8-millimeter (mm) helical-scanning devices use a rotating head much like an 8-mm camcorder.

The stationary magnetic recording heads record data on a 1/4-inch tape. They can create a maximum of 18 tracks, which run parallel to the tape length and contain 10,000 bits per inch. Thus, the tape holds up to 22KB per inch of tape (yielding more than 150MB on a 600-foot tape). During operation, the tape speeds along at 90 inches per second, which means the maximum throughput of tape data is slightly more than 2MB per minute.

Helical-scanning tape drives currently are based on a drive manufactured by Exabyte (EXB-8200). They use a tape head that rotates at 1,800 revolutions per minute (rpm). The head rotates at an angle of 5 degrees with respect to the length of the 8-mm tape. This angle allows the head to create diagonal tracks about 3 inches long on the tape and containing 8,192 bytes of user data (12,720 total bytes) per track. The tracks are also much more dense than the stationary head devices, with 820 tracks per inch or about 500KB of user data per inch of tape. The tape itself moves slowly—at .043 inches per second—but the denser tracks and rotating head yield a relative speed of 148 inches per second between the head and the tape. Thus, the maximum throughput of tape data is more than 10MB per minute. The recording density is 43,200 bits per inch.

The rotating head on the helical-scanning drives also allows the drive to perform read-after-write verification without a second head. The rotating drum actually contains a read head, a write head, and a servo head that enables the drive to read the data immediately after they are written to tape in order to verify proper storage. The hardware also can correct any errors by making the bad section and rewriting the data on a later section of tape without software intervention. With stationary heads, the tape must be rewound or a second head must be present to accomplish this read-after-write verification.

The CORE, Mountain, and ADIC backup tape drives on the left all use DC600 (600-foot) cartridges. Expect to see new versions of these systems soon using 1,000-foot cartridges with a 250MB capacity. The Emerald and Maynard systems use 8-mm, helical-scanning tape with 2.2GB capacities.

While these differences make it appear that the helical-scanning drives would be much faster, the differences are not as great as they appear from these statistics. Many other factors determine the actual backup speed. These figures are the maximum theoretical throughput from the tape head to the tape and not a true measure of the throughput from disk to tape.

Make no mistake: disks do fail. But system administrators grow complacent when failures are infrequent. Fires, floods, and earthquakes happen, so data disaster recovery plans should include off-site storage of backups and alternate systems on which to load data. For many companies, on-site fireproof safes are one answer. Safes provide security and protect against many hazards, while keeping tapes easily accessible. The logical way to meet the needs for a complete system restoration is to back up the entire network regularly. Frequent complete backups, however, can be impractical on very large networks, taking many tapes and hours to complete.

Much more common than total disasters is the need to recover files deleted or damaged through human error or hardware failure. Organizing files to minimize the impact of errors by users and system administrators is important in developing a LAN's directory structure. When a user deletes a file or directory, the administrator needs to bring those files back in quickly. This common situation forces us to consider carefully single-file restoration in planning a backup strategy.

Maintaining a database of backups and cataloging each tape takes care of identifying tape contents. A less-demanding method is to organize backup around disks and critical areas of data. Answers to the basic question of what and when to back up become complex in large LAN environments. The result may be inconsistency and disarray when viewing the entire network file system. The effect on backup strategy is that the location and importance of data are not immediately obvious. Correcting the problem of data organization is often the first step toward effective backup.

A WORKABLE STRUCTURE

Separating static files from files that change frequently simplifies backup and restore operations, as it does all LAN management. As directory structures grow, static and dynamic files can become mixed in a maze of directories. For example, applications that the accounting group uses should not be mixed into the accounting users directories. Executable programs from dynamic directories should be separated close to the root. The higher this distinction is made in the directory tree, the easier it is to find and specify files for backup. Try to create a simple directory structure that has distinct static and dynamic branches.

Isolating all user data in a limited number of paths lays the groundwork for a variety of backup strategies. In addition, isolating all executable files allows the LAN administrator to manage software updates and monitor possibly destructive programs that users may introduce onto the LAN.

Different work environments may have different criteria for control and backup frequency. In a software development environment, for example, source code is backed up frequently while executable files generated from that code may be reconstructed and would not need to be backed up.

When selecting files to be placed in the directory path for regular backup, the system administrator must be sure to include *invisible* files—those

updated by applications without direct user knowledge. These are files that save default options, configuration information, supplementary dictionary files, and other system files not clearly visible to network users. These configuration files should be maintained in a separate dynamic directory, if possible.

Another hidden area that should be included in backups is the network-system files. These include the user and security information vital to reconstructing the operating environment efficiently.

SCHEDULING BACKUP

All backups begin from a baseline of a complete backup and some form of incremental backup until the next baseline backup. Because none of the major LAN operating systems supports a directory or file across multiple disks, each disk in a multidisk LAN can be treated as a separate entity in planning backups. Therefore, you can run a complete baseline backup for each disk on different days: disk 1 on Monday, disk 2 on Tuesday, and so on.

After the baseline backup are two primary strategies for incremental backups. One is to back up any file having the archive bit turned off, which indicates that someone has changed it since the last backup. The other is to backup files that have had the date changed since the last baseline. Each method carries advantages and disadvantages.

Incremental backups by archive bit yield the shortest backup requirement if performed daily on only the files changed since the last incremental backup. Having to restore from several of these incremental backups, however, can be laborious because each tape must be restored in sequence. A daily backup of all files having a file date later than the baseline date increases the required backup time as each day adds more files to the "new file" category, but it simplifies restore because all files changed will be on the last tape run and intermediate tapes for the most part can be disregarded.

The question of how long to keep tapes before they are reused is difficult. The answer is usually one hour longer than anyone thought possible. Barring keeping all tapes forever, a good strategy for reuse is based on a cost analysis of losing the data altogether and recreating data from some given point in time. This analysis applies to the frequency with which backups are shipped off-site to protect against a catastrophic incident such as a fire. Most sites arrive at some compromise of keeping some baseline backups for a long time and maintaining a shorter period for sequential baseline and incremental backups.

As difficult as it may be, companies must attempt to place dollar figures on the risk of losing data. A table including factors such as personnel costs for reentering data since the last backup, personnel hours lost while a system is down, and the cost of a total loss of all data should be considered. A careful look may show that the fate of a firm rests on the recovery of data. This information will help put the cost of backup administration, tape transfer to remote sites, tape drives, and tapes in perspective. A careful risk analysis can pinpoint critical applications and directories that may merit full backups much more frequently than most other data on the LAN. Treating these priority directories as a separate backup task may make economic sense.

A careful risk analysis pinpoints applications and directories that merit full backups more frequently than most LAN data.

A HOST OF OPTIONS

Many software options are available for establishing an effective backup system. Most backup software lets administrators select files by drive letter, by directory and file specifications, by an archive bit that indicates changed files, and by the modification date and time on the files. A majority of the network file systems and backup devices provide the capability of using an archive bit to select files that have changed since the last backup.

When you must have an operator present during a backup and it is inconvenient to have someone work after normal hours, consider performing a full backup periodically during working hours and supplementing it with unattended incremental backups each evening when network activity is negligible. The full backup may miss open files but the nightly operations will back them up.

Batching backup routines. Automate backups when possible. In managing backups of multiple disks over many days, for example, a menu interface is critical. In addition, you can execute most tape software from batch files; even when an operator is needed for the backup, using a batch file limits the possibility of human error and ensures consistency in the backup process. In addition to batch files, consider using a menu to direct the selection of backup routines. A simple batch file to display direction and a list of options may suffice, or a menu software package may be in order.

Validating backup. It is difficult to identify problems in backup procedures until it is too late. You can apply many checkpoints, however, to validate the contents and integrity of the tapes. Some tape software permits an actual comparison of the tape data and disk data at the end of the backup. This can be time prohibitive on large LANs, but it is a solid verification of tape contents. Be mindful that users may be changing files while the backup is running, creating verification errors that are not actually tape errors.

Other tape software permits read verification of the tape contents. In this case, all data on the tape are read to ensure that no tape read errors exist. This verifies tape integrity but does not guarantee that the data agree with the disk contents. This option, however, requires less time.

Another way to check for problems is to use software-activity log files or backup session printouts. These show tape activity along with any error messages, skipped files, or other problems. When these files grow too large to read, they can be searched for key words, such as completed, error, fail, or other messages that help determine if the backup had problems. This avoids problems that go undetected in unattended backups. Finally, you should perform periodic restorations from tapes to test the system. This will expose problems in the restore operations and test tape integrity.

Backup failure plans. The backup process can have its own problems. When laying out backup procedures, consider what to do when backups do not run properly. How long can you go without backups? How do you get back on schedule after a problem without missing data? It is far better to deal with these questions and anticipate situations beforehand than during a crisis.

Several options are available for getting back on schedule after a simple failure, such as a power outage. Aside from simply skipping backup for that

day, you could run the backup during operating hours, although the backup will miss open files. A partial backup of important files may suffice to resume normal operations. Critical systems may require a full backup before continuing partial backups to ensure that files have not been missed as a result of a corrupted backup.

Finally, consider your hardware risk. Short of buying a spare backup unit, you can keep a list of vendors who stock your unit so one can be purchased in an emergency. If the vendor who supplied the unit stocks it, then it may be possible to exchange the unit, or obtain a loaner while the unit is being repaired. Some manufacturers sell service contracts that provide spares on 24-hour notice. Look back at your risk analysis—don't try to save pennies on backup.

Security. Backup systems introduce many security problems in a network environment. For one, a station backing up an active network requires the operator to have supervisor privileges, and an unattended workstation logged into the network as a supervisor is an open invitation. The most basic protection dictates that a logout be performed at the end of the backup routine. This does not, however, prevent someone from halting the backup process to obtain access to the system.

A better solution is to disable the keyboard. Most 80286-and 80386-based machines have a key that disables the keyboard. Another method is to disable the keyboard by using the DOS CTTY command to redirect I/O to NUL within a batch file. At the end of the batch file, a second CTTY reenables the keyboard after logging off the network. Such a batch file might look like this:

```
BREAK OFF
CTTY NUL
BACKUP
LOGOUT
CTTY CON
```

Some software is available that disables the keyboard, but be certain that the backup will continue with the keyboard disabled. A backup machine in a locked room is a good idea anyway.

Another security concern is that network backups can be restored to local disks, circumventing the LAN security system. A user who cannot access a file because of LAN security might have access to the tapes and the backup unit. Locked storage for tapes is the most obvious solution. Some manufacturers provide for encryption of back-up data.

Backup storage. Besides security threats, other hazards, such as extreme temperatures, magnets, and humidity can destroy a tape library. Backups should be stored in a safe area away from normal traffic and sources of heat—direct sunlight, office heaters (window sills are out of the question). A locked room or cabinet is wise even if data security is not a concern.

When storing backups, more than tape is required to recover your LAN—tapes can be used only when the system is operating again. Store such items as the LAN operating-system installation media, the tape unit software, and other diskettes needed to recover from a major disaster. Look closely for

> *Nine-track units are good for exchanging data with larger systems, but their capacity and software are inadequate for large LANs.*

software that cannot be backed up or is not recoverable from tapes—such as LAN licenses for some software. Overlooking these could cost a great deal of time when the system is down.

Other issues. Many LANs have grown alongside larger computer systems that use nine-track tapes extensively. As a result, many have nine-track systems backing up the LAN itself. Although nine-track tape units for PC environments are an excellent way to exchange data with larger systems, their storage capacity and throughput are often inadequate for large LANs and the software often lacks features helpful in handling large amounts of data in the PC world. The cartridge tape and 8-mm, helical-scan products (similar to video recording equipment) offer capacity and features that make them better suited for LAN backup.

TAPES TESTED HERE

The need for high-capacity tape backup units is a natural extension to recent advances in hard-disk technology and LAN growth. With internal PC hard disks of 300MB becoming more common and capacities greater than 1GB more available and affordable, the required advances in tape architecture are hitting the market. Not only are hard-disk capacities growing, but administrators are adding new hard disks and servers to existing LANs, creating systems with hundreds of megabytes of data to manage.

Many tape systems are aimed at this market and support the features and options needed in a large LAN environment. Capacities of the tape units reviewed here range from 150MB to 2.5GB. These drives are aimed at a wide range of LAN sizes and meet different needs. Many networks appear to the workstation simply as a DOS device and therefore are supported at least in part by these devices.

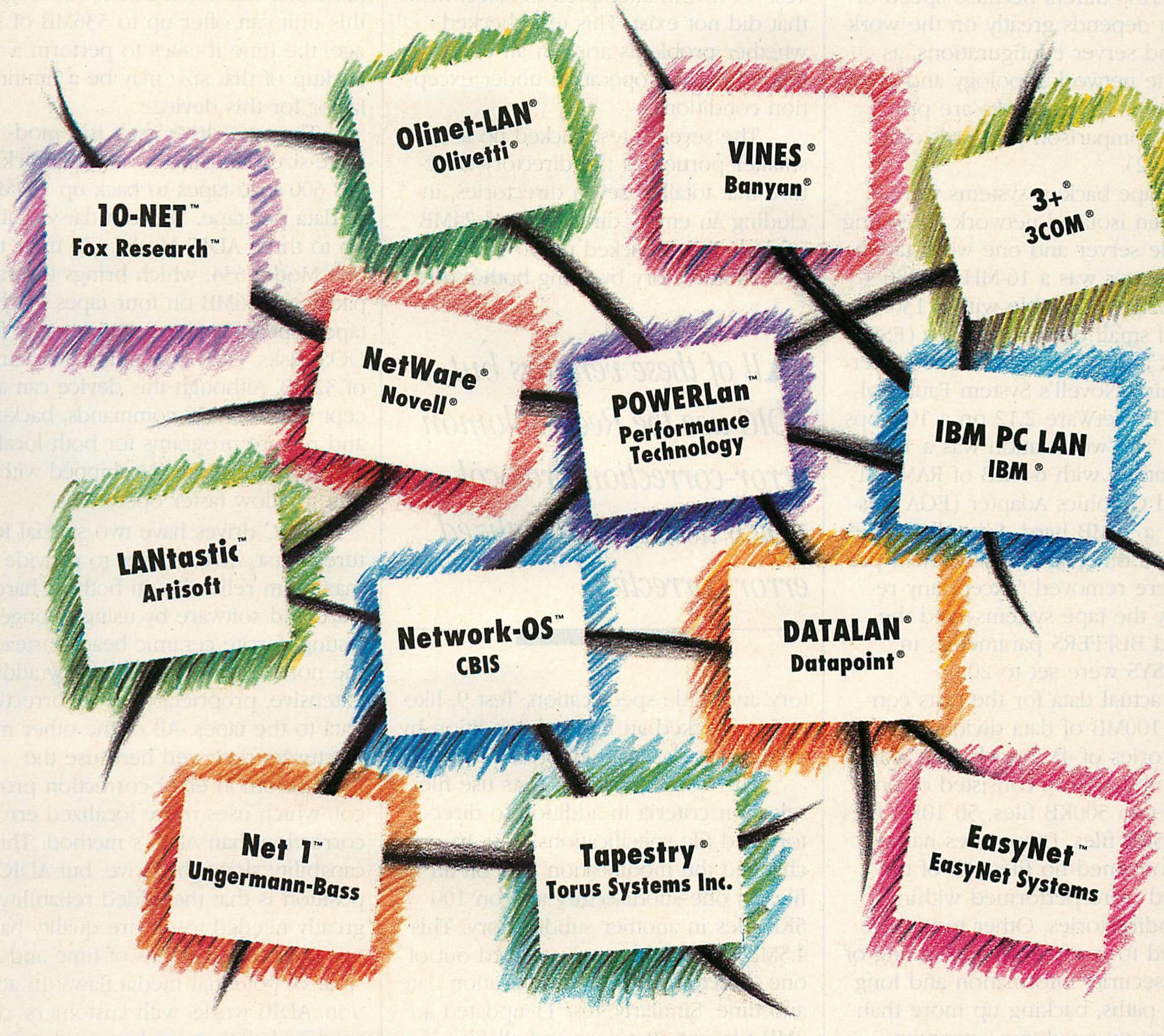
Table 1 is a features comparison of the units reviewed. The maximum configuration capacity shown is the total capacity that one controller and "chain" of tape units can support. The ADIC and Mountain units support four tape drives off one controller in a daisy chain. Although you can place multiple controllers in a machine, the two controllers would not appear as one cohesive unit to the software.

Do not assume that standards followed in the hardware interface, such as the small computer system interface (SCSI), allow the use of controllers other than the ones provided with the unit. The software is written to use the hardware options present on the manufacturer's controller, which may differ from other controllers. This interface information simply provides a glimpse of what is being used to transfer data to the units.

The ability to create a tape on one drive and read it from another *similar* drive was tested and included in the section on drive-to-drive compatibility. Although this test does not guarantee such compatibility among all units, it was tested between at least two units to check for any blatant problems.

"Backup Read Verification" refers to the capability of reading the tape contents without restoring the data, thereby checking the integrity of the tape itself. The "Backup Comparison Verification" and "Restore Verification" fields indicate the capability of actually comparing the data on disk with the data on tape to check that the data were properly transmitted and stored. Finally, several of the units provide the capability of reading the tape after it is written without a second pass through the tape. This is achieved through the hardware configuration and does not require the time-consuming activity of rereading the tape. Often, any errors the hardware configuration discovers are corrected without error messages or additional software overhead.

We back up what we don't sell.



POWERsave™ is the first generic tape backup and restore facility for MS®-DOS compatible PC networks. Whether your disks belong to workstations or servers — POWERsave backs them all up.


POWERsave with POWERstreamer IV

Big. Unattended, it supports up to 16 tape drives of mixed types, including 2.2 GB cassettes, for "an incredible 32.704 GB of data...without changing tapes"* using POWERstreamer IV™. And if that's not enough, an operator can feed POWERsave up to 100 tapes in succession.

Fast. PC Magazine benchmarks "...the POWERstreamer IV roughly twice as fast as The VAST™ Device (from Emerald Systems™) on all tests."*

See us at COMDEX booth # 2402

Highly reliable. PC Magazine "..tried to torment the software, with little success."* Replicated directories, tape overwrite protection, dual validation, and other safeguarding features are built in.

Easy to use. Simple menu options allow quick and selective restore by file, directory, or volume.

Flexible. POWERsave supports Exabyte 2.2 GB 8mm cassettes, IBM™ 3480 HI/TC cartridges, and 150 MB tapes, all with SCSI controllers; plus 60, 125, or 150 MB tapes using QIC-36 or QIC-02 standards.

By the way, we do back up and sell one of the networks shown here — POWERLan!

PERFORMANCE TECHNOLOGY

Call 1-800-825-LANS

Dealer inquiries invited.

800 Lincoln Center • 7800 IH-10 West • San Antonio, Texas 78230

* Frank J. Derfler, Jr., and C.G. Milligan, "2-Gigabyte Lan Server Backups," *PC Magazine*, Jan. 17, 1989 (Volume 8, Number 1).

POWERLan, POWERmirror, POWERsave, POWERserve, and POWERstreamer IV are trademarks of Performance Technology, Inc. All other products mentioned are trademarks of their respective manufacturers.

CIRCLE NO. 113 ON READER SERVICE CARD

Test spins. The drives were evaluated for functionality and performance. This provided a look at the design of the systems and revealed many differences in their operation. Performance on individual LANs differs because speed of operation depends greatly on the workstation and server configurations, as well as the network topology and operating system. These results are provided for comparison purposes only (see table 2).

The tape backup systems were tested in an isolated network consisting of one file server and one workstation. The file server was a 16-MHz 80386-based PC/AT compatible with a 130MB enhanced small device interface (ESDI) hard disk and 2MB of RAM. The server was running Novell's System Fault Tolerant (SFT) NetWare 2.12 on a 10-Mbps Ethernet. The workstation was a 10-Mhz AT compatible with 640KB of RAM, an Enhanced Graphics Adapter (EGA) display, and a 40MB hard disk. All device drivers and other memory-resident programs were removed (except any required by the tape systems) and the FILES and BUFFERS parameters in CONFIG.SYS were set to 20.

The actual data for the tests consisted of 100MB of data divided into 25 subdirectories of 4MB each. The 4MB in each subdirectory consisted of one 2MB file, two 500KB files, 50 10KB files and 100 5KB files. Directories named EMPTY contained no files. All of the tests listed were performed within these subdirectories. Other tests were performed to verify proper handling of network security information and long directory paths, backing up more than 10,000 files on a volume, spanning multiple tapes, and other software features. None of the drives running their most recent versions failed any of these tests. The results for the listed tests are representative of all speed test results.

Not all units could be tested on every feature. The verify options, for example, differ greatly among the units. While the Emerald and CORE drives provide a read verification of the tape data, the Maynard and Mountain drives allow a comparison of tape and disk data as verification. Because the options differ, the verify options could not be compared directly. Therefore, the backup and restore tests were conducted with no verification so that the times would compare like activities. Other tests were treated in the same way to achieve a fair comparison.

The first three tests—erase, tension, and format—are self-explanatory, but note that only the ADIC drive requires tape formatting. The fourth test backed up all 100MB of data in the \BACKUP directory. Test 5 was a backup of all of the 2MB files from each of the 25 subdirectories, for a total of 50MB. Test 6 (*.NUL) attempted to select files that did not exist. This test checked whether problems arise in an unattended backup operation under exception conditions.

The seventh test backed up a smaller portion of the directory structure that totalled seven directories, including an empty directory and 24MB of data. Test 8 backed up 50 10KB files in a subdirectory by using both a directory and a file specification. Test 9, like test 6, checked an unusual condition by trying to back up an empty directory.

All of these vendors but ADIC use the Reed-Solomon error-correction protocol, which uses more localized error correction.

The last two backup tests use file selection criteria in addition to directory and file specifications. Test 10 changed the modification data on all files in one subdirectory and on 100 5KB files in another subdirectory. This 4.5MB of data then was selected out of one directory path by modification date and time. Similarly, test 11 updated a 2MB file one directory and all files in another. These files were then backed up using the archive bit selection.

The restore tests were similar to the backup tests and were performed on the tape created in test 4 (all files—100M). Tests 14 and 17 checked the handling of exception conditions when no files were selected. In particular, they tested how long it takes to search a 100MB tape only to find that the data are not on that tape or not on that particular tape volume. The data restored in tests 12 through 17 correspond to the data backed up in tests 4 through 9 respectively.

Advanced Digital Information Corporation. ADIC has been a pioneer in providing quality, high-capacity backup. The ADIC Model 634 Data Library is unique in its design: its method of enabling the tape to appear as a DOS disk drive proves to be both an asset and a liability. You can use DOS commands such as XCOPY and DIR, but DOS errors such as a corrupted file will stop an ADIC backup dead in its tracks. ADIC's commitment to tape security and error correction also directs this product to a particular market segment. Although this unit can offer up to 536MB of storage, the time it takes to perform a backup of that size may be a limiting factor for this device.

The tape drive itself is a moderate-sized unit that uses multitrack DC 600-style tapes to back up 134MB of data per tape. You can daisy-chain up to three ADIC Model 630 units to one Model 634, which brings the capacity to 536MB on four tapes. Each tape appears to the system unit as four DOS disks, each containing a maximum of 32MB. Although this device can accept normal DOS commands, backup and restore programs for both local and network disks are shipped with the unit to allow faster operations.

ADIC drives have two special features. First, ADIC strives to provide maximum reliability in both its hardware and software by using a longer lasting, ferrite ceramic head (instead of the normal brass head) and by adding extensive, proprietary error-correcting data to the tapes. All of the other manufacturers reviewed here use the Reed-Solomon error-correction protocol, which uses more localized error-correction than ADIC's method. This capability slows the drive, but ADIC's position is that the added reliability is greatly needed to ensure quality backups over long periods of time and in spite of potential media flaws. In addition, ADIC works with customers' damaged and even erased tapes to restore what may appear to be irrecoverable data. This is a for-fee service, but is well worth consideration. All systems were found to be reliable in the *PC Tech Journal* tests, but the problems ADIC addresses may show up in some small percentage of cases.

You install the ADIC controller card after configuring the hardware option of a direct memory access (DMA) channel. The software is copied onto the boot disk to allow the loading of a device driver in CONFIG.SYS.

The ADIC software combines command-line and menu-driven utilities. You perform tape formatting, tensioning, and erasing through command-line options (version 5.2 of the ADIC data library software), but conduct back up and restore via menu utilities (version 1.18 of the NSAVEIT/NGETIT software). You can set up a batch file to run backups unattended by saving the menu

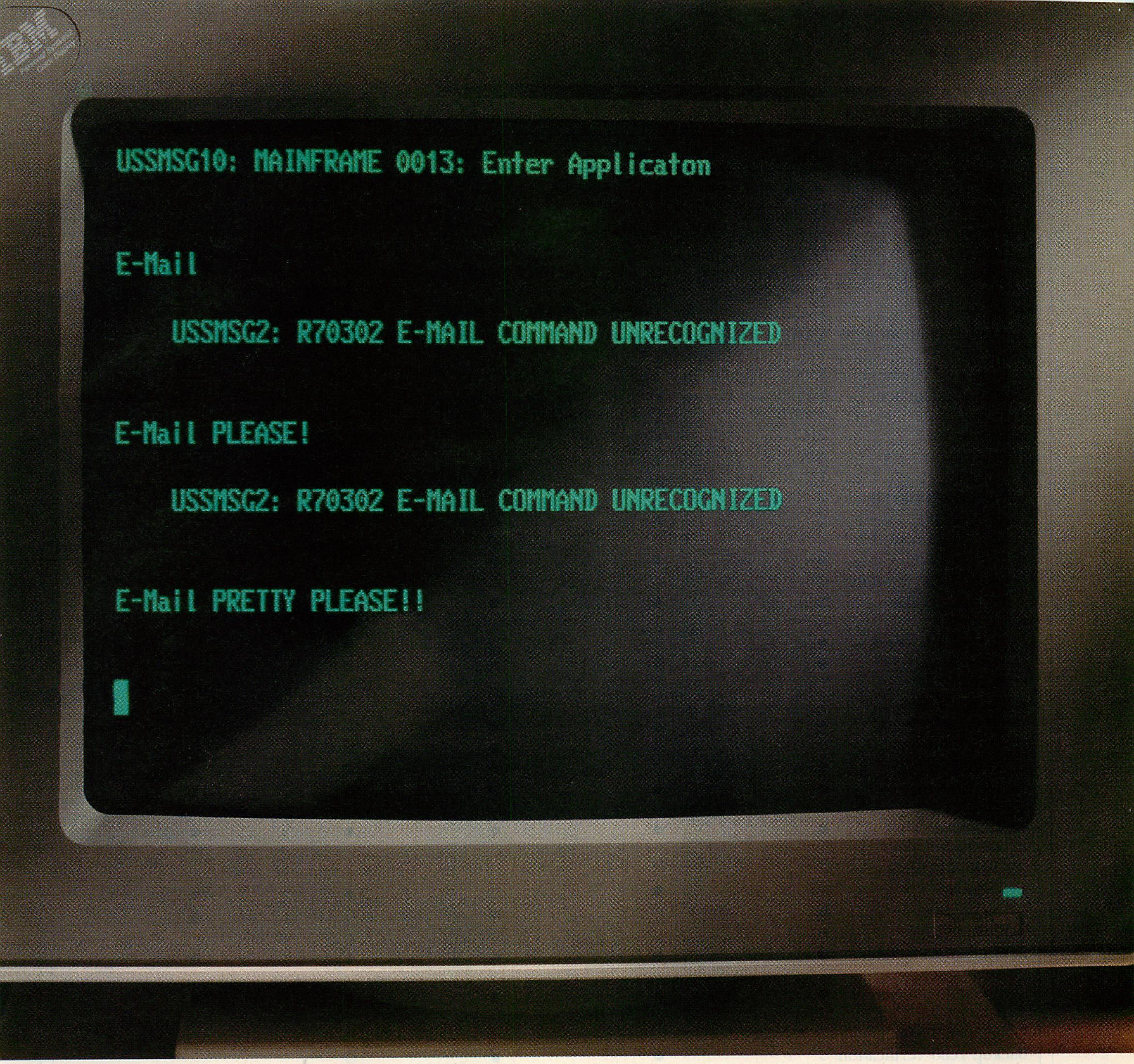

USSMSG10: MAINFRAME 0013: Enter Applicaton
E-Mail
USSMSG2: R70302 E-MAIL COMMAND UNRECOGNIZED
E-Mail PLEASE!
USSMSG2: R70302 E-MAIL COMMAND UNRECOGNIZED
E-Mail PRETTY PLEASE!!

TABLE 1: *Features Comparison*

	ADIC	CORE	EMERALD	MAYNARD	MOUNTAIN
Model	Model 634 with Model 630[a]	Core 150/250E	The VAST Device	Maynstream 2200HS	Model 7300 with Slave Unit
List price	Model 634 $3,900 Model 630 $2,900	$2,295	$6,995	$6,995 (PC-bus) $7,095 (PS/2)	$3,395 (each) $3,495 (PS/2)
Tape specification	DC600XTD or DC600XTD/HC	DC600 or DC1000 series	8-mm cassettes	8-mm cassettes	DC600 series
Tape capacity	134MB	150MB or 250MB	2,200MB	2,200MB	150MB
Maximum configuration capacity	536MB	250MB	2,200MB	2,200MB	600MB
Dimensions (inches)	5.25 by 10.5 by 14.5	2.85 by 5.75 by 10.5	5.6 by 8.5 by 10.6	3.5 by 5.88 by 14.5	7.2 by 4.7 by 14.5
Hardware interface	Proprietary PC-bus controller	Proprietary PC and PS/2 controllers	SCSI PC and PS/2 controllers	SCSI PC and PS/2 controllers	QIC PC and PS/2 controllers
Base address	21CH	280H, 300H	200H, 350H	360H, 370H	200H, 3FFH
Interrupts	N/A	27	27	27	27
DMA channels	13	13	13	13	13
OPTIONS SUPPORTED					
Command line interface (backup and restore)	○	●	○	●	●
Menu interface	●	●	●	●	●
Programmatic interface	○	○	○	○	○
Automatic software installation	○	●	●	●	●
Span multiple tapes	●	●	○	●	●
Drive-to-drive compatibility	●	●	●	●	●
BACKUP OPTIONS					
Unattended	●	●	●	●	●
By date/time	○	●	●	●	●
By archive bit	●	●	●	●	●
By file/directory specification	●	●	●	●	●
LAN security information	●	●	●	●	●
RESTORE OPTIONS					
Unattended	○	●	○	●	●
By date/time	●	○	●	○	●
By changed file	●	○	○	○	○
Redirected to different volume	●	●	●	●	●
Redirected to different directory	●	●	●	●	●
VERIFY OPTIONS					
Backup read verification	○	●	●	○	○
Backup comparison verification	○	○	○	●	●
Restore verification	○	○	○	●	●
Read-after-write verification	○	○	●	●	●

● = Yes ○ = No N/A = Not applicable

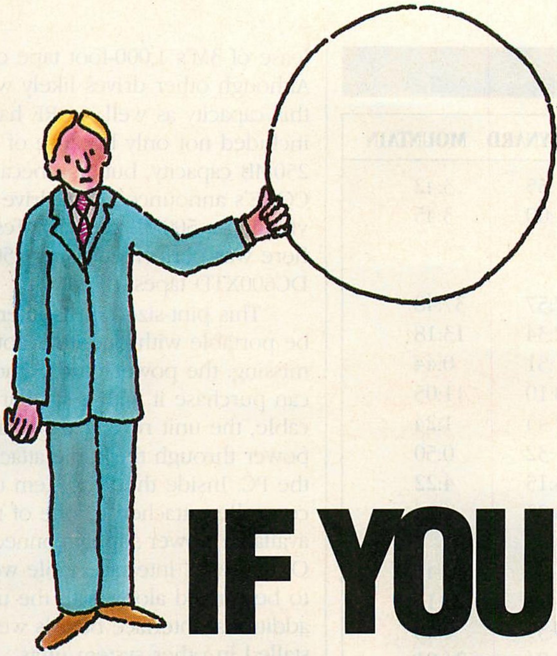
[a] Model 634 is attached to the PC controller with as many as three Model 630 systems attached in a daisy-chain to the master 634 unit.

Software has been the Achilles heel of LAN tape backup systems. More attention is now being paid to providing flexible systems. Each of these packages offers a menu-driven interface of some kind and many more options for backup, restore, and verify operations.

options to a file and starting the backup program with the saved information. The software allows the specification of files and directories that are excluded from backups and restores. It does not support password protection of backup tapes or file selection by date and time on backups.

The operation of the ADIC tape drives differs from the other backup units. ADIC drives must use formatted tapes; you can either purchase formatted tapes (DC600XTD/HC) or format blank tapes using an ADIC program. Tapes are automatically "loaded" when you place them in the tape drive, but you must "unload" them using software before the tape can be removed or before the system is powered down. Running ADIC from a batch file becomes critical to avoid forgetting this step.

The menu software is relatively simple. The network software must be started with a network volume as the



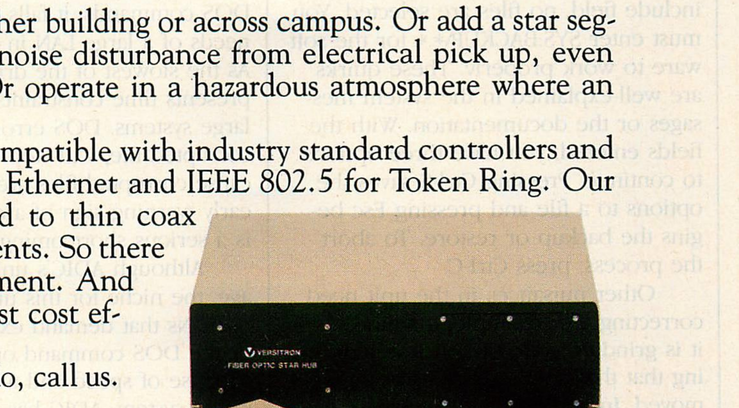
IF YOUR LAN CAN'T DO EVERYTHING YOU WANT IT TO CALL (800) 537-2296

Like extend to another floor or another building or across campus. Or add a star segment to a bus topology LAN. Or avoid noise disturbance from electrical pick up, even lightning. Or meet cabling fire codes. Or operate in a hazardous atmosphere where an electrical arc would be dangerous.

Our fiber optic LAN products are compatible with industry standard controllers and software that conform to IEEE 802.3 for Ethernet and IEEE 802.5 for Token Ring. Our fiber optic LAN segments can be added to thin coax Ethernet or twisted pair Token Ring segments. So there is no need to scrap existing LAN equipment. And you can configure a new LAN in the most cost effective way for your specific application.

So for all the things your LAN can't do, call us. We'll jump.

Distributor, Dealer and VAR inquiries invited.



VERSITRON

9005-8 Junction Drive · Annapolis Junction, MD 20701 · (800) 537-2296 · (301) 497-8600 · FAX (301) 497-8694

CIRCLE NO. 138 ON READER SERVICE CARD

TABLE 2: ***Comparative Performance***

	ADIC	CORE	EMERALD	MAYNARD	MOUNTAIN
Erase time	3:04	2:59	2:01	1:55	3:42
Tension time	—[a]	2:59	—[b]	1:00	3:45
Format time[c]	37:14	—	—	—	—
BACKUP TESTS					
All files (100MB)	194:56	27:31	43:19	27:57	37:48
2MB files only	89:54	10:58	13:41	12:34	13:18
*.NUL (does not exist)	7:15	0:50	2:34	1:51	0:44
BACKUP\DIR.02\...	49:56	6:47	10:32	8:10	11:05
BACKUP\DIR.03\SUB.05\10KB[c]	5:27	0:50	2:54	1:44	1:24
BACKUP\EMPTY\...	3:40	0:37	2:37	1:32	0:50
Modify time	—[d]	2:39	4:29	3:15	4:22
Archive bit	15:12	2:57	4:52	3:23	4:34
RESTORE TESTS					
All files (100MB)	123:50	22:51	45:04	24:57	33:41
2MB files only	69:53	17:06	19:38	14:13	25:16
*.NUL (does not exist)	12:23	1:23	3:18	9:31	0:46
BACKUP\DIR.02\...	41:37	6:59	15:09	13:04	24:01
BACKUP\DIR.03\SUB.05\10KB[c]	8:45	16:09	4:34	9:28	21:45
BACKUP\EMPTY\...	6:45	0:49	9:36	9:36	6:21

All times are in minutes:seconds.

[a] Tensioning is performed during format.
[b] Tensioning not available.
[c] Preformatted tapes are available.
[d] Modify time is not a function of the software; it will work with DOS XCOPY.

ADIC's vintage design fared poorly in flat-out speed; CORE and Maynard generally vied for the speed honors. Backup and restore of 100MB is the most significant test. Dealing with extreme and error situations had widely differing results.

default drive. The software is somewhat particular in the contents of the fields, although entering data is simple. For example, it uses network volume names (such as SYS:) in place of drive letters (such as F:). It does not accept a beginning backslash at the root directory in directory and file specifications. If you enter SYS:\BACKUP*.* in the include field, no files are selected. You must enter SYS:BACKUP*.* for the software to work properly. These quirks are well-explained in the system messages or the documentation. With the fields entered, you have three options to continue. Pressing Ctrl-S saves the options to a file and pressing Esc begins the backup or restore. To abort the process, press Ctrl-C.

Other nuisances in the unit need correcting. For example, it sounds as if it is grinding coffee when it is indicating that the tape is ready to be removed. In addition, the software places log files and other temporary files on the network disks: the operator cannot name or place them. The estimated completion time is meaningless in many cases (in one case, the estimate equaled 248 minutes and the actual equaled 12 minutes). Although these quirks should be fixed, they do not constrain the system.

Although the software does not require extensive explanation, the format and content of fields require more description than is given in the software documentation. The suggested maintenance on the drive, however, is minimal; the heads need cleaning after every 80 hours of use.

Although this unit accepts normal DOS commands, it falls short of the needs of a large LAN in several areas. As the slowest of the drives tested, it presents time constraints for extremely large systems. DOS errors, such as a corrupted file, will stop backup. Because corrupted files are sometimes an early warning sign of a dying disk, this is a serious shortcoming.

Although ADIC's units show their age, the niche for this unit would be on LANs that demand extra reliability or the DOS command options at the expense of speed and a few nuisances in the system. ADIC has announced a new series of LANbacker systems that were not available for review.

CORE International. The 150/250 E, CORE's entry into the 250MB capacity, comes largely as the result of a new tape introduced by 3M Corporation. Built on the standard multitrack DC 600-style magnetic tape, this drive will have the 250MB capacity with the release of 3M's 1,000-foot tape cartridge. Although other drives likely will have this capacity as well, CORE has been included not only because of the 250MB capacity, but also because of CORE's announced dual-drive unit yielding a 500MB capacity. Testing here was performed using 150MB DC600XTD tapes.

This pint-size unit is intended to be portable with one item noticeably missing: the power cord. Although you can purchase it with a standard power cable, the unit reviewed obtained its power through the cable attached to the PC. Inside the PC system unit, the controller attached to one of the PC's available power-supply connectors. Only the PC interface cable would have to be carried along with the unit if additional interface boards were installed in other system units.

Installation consisted of setting hardware jumpers and switches to configure the usual I/O address, interrupt, and DMA channel options. Software installation was menu-driven, after which the selected hardware options had to be configured in the software.

Version 2.0 of the COREtape software provides both menu-driven and command-line options for performing tape operations. In addition to the basic capabilities shown in table 1, the system allows password protection of tapes, excluding file and directory specifications from the backup, and the naming of tape volumes. It allows you to generate lists of files for backup (called *catalogs*) and provides a menu-driven, file-management utility. You can automate backups at both specified and repetitive times during the week. One nice feature in unit operation, but not in the documentation, is the ability to retry skipped files at the end of the backup operation. These features are supported for both DOS and Xenix.

CORE's recommended preventative maintenance includes cleaning the heads after every eight hours of normal use (every two hours if new tapes are used) with a cleaning cartridge or isopropyl alcohol and a swab. On large LANs, daily cleaning is required.

The menu design can stand improvement—frequently used options are not easy to locate. Most options are selected from the middle of the list because F1 is always HELP and F10 is used to save options or begin operations. The selections jump from one function key to another so that the menus must be read carefully every time. In addition, it takes many menu selections to accomplish simple tasks.

Ada Leadership

The Complete Ada Solution

Meridian's Ada development systems are oriented towards the professional developer. Meridian is the market leader in personal workstation Ada and provides the most complete Ada programming environment available. No other Ada environment offers graphical program representation, supports what-if analysis, and includes an integrated editor. In addition, The Booch Components™, available exclusively from Meridian, are the most widely used software components for the PC.

Solid Technology

Meridian's technology is the choice of many cutting-edge computer companies, including minisupercomputer manufacturers Ardent and Multiflow. Meridian's core technology has been fielded and refined for over eight years by thousands of professional users.

product profile

PC Professional Developer Kit (PDK) — The best cost effective developing environment for the Professional PC user. The Professional Developer Kit includes: Extended mode AdaVantage™ Compiler, which breaks the 640K barrier, Real Mode AdaVantage Compiler, Optimizer, Source Level Debugger, Ada Developer Interface (ADI), and DOS Utility Libraries.

Mac Professional Developer Kit (MPDK) — This is the most complete set of Ada tools for the professional Macintosh developer. The Mac Professional Developer Kit includes: Mac AdaVantage Compiler, Optimizer, Source Level Debugger, Utility Library and Mac Environment Library.

PC Developer Kit (DK) — A perfect Ada Programming Support Environment for IBM PC's and compatibles. The Developer Kit includes: Real mode AdaVantage Compiler, Source Level Debugger, Ada Developer Interface (ADI), and DOS and Utility Libraries.

Macintosh AdaVantage Compiler — Mac AdaVantage Compiler is the only Ada compiler for the native Macintosh Operating system. This offering also includes the Optimizer.

Features Comparison

	Meridian	Alsys	Integrada
In-House Ada Technology	●	●	
Multiple Platform Support	●	●	
Extended Mode Compiler	●	●	
Real Mode Compiler	●		●
Optimizer	●	●	●
Source Level Debugger	●	●	
Chapter 13 Support	●	●	
The Booch Components™	●		
Integrated Editor	●		●
Graphical Presentation	●		
"What-If" Analysis	●		
Complete DOS Binding	●	●	
80X87 and Software Floating Point	●	●	●
Pragma Interface to Microsoft-C	●		
Annual Support	●	●	●
Professional Documentation	●	●	

Special Offer

Real Mode AdaVantage Compiler/Linker
ADI with Editor

$595.00

offer valid until June 15, 1989

NAME: ____________________

COMPANY: ____________________

ADDRESS: ____________________

CITY, STATE, ZIP: ____________________

PHONE: ____________________

VISA or MasterCard Number ____________________ Exp. Date

SIGNATURE ____________________

MERIDIAN
SOFTWARE
SYSTEMS, INC

23141 VERDUGO DRIVE • SUITE 105 • LAGUNA HILLS, CALIFORNIA 92653
800/221-2522 (Outside California) • 714/380-9800 (Inside California)
Telex: 650-268-0547 MCI • Fax: 714/380-1683

CIRCLE NO. 230 ON READER SERVICE CARD

Consider the erase operation. To erase a tape, you press F6 to select Tape Utilities. Next you press F5 to select the erase option. Then you press F10 to tell the software you actually want to begin the operation. Then a message explains that the data on the tape will be lost so "Y" must be entered to continue. In case you did not mean to do all this, another message explaining that tape data will be lost is displayed and you must enter "Y" again. The number of required selections is excessive.

Aside from the menu question, the petite CORE felt and behaved like a rugged heavyweight. If you need to back up a lot of stand-alone PCs or you simply like the portability for support of many sites, the CORE drive may be just the ticket.

Emerald Systems. The VAST Device is an 8-mm, helical-scan tape backup unit introduced into the PC market more than a year ago. Although early units suffered from hardware problems and were shipped with incomplete, preliminary software, most of the problems appear to be resolved, leaving a reliable, complete backup unit. The final version (1.21) of its EmSave software that Emerald sent *PC Tech Journal* for review worked as advertised. EmSave adds a nice menu interface to the product and offers unique features for the LAN environment.

The VAST Device uses helical-scanning technology to store as much as 2,200MB on a single 8-mm cassette tape. These tapes are less than half the size of a DC600 cassette but are able to achieve more than 14 times its storage capacity. The unit's SCSI interface permits rapid transfer between the PC and the tape unit; it delivers performance comparable to the fastest DC600 cassette units but has a much higher storage capacity.

Installation is simple. The only hardware switches to set determine the I/O address of the controller. Once you install the controller and the unit is connected properly, you install EmSave by running a setup program located on the original diskette. Because EmSave is based on Microsoft Windows, you must set the Windows software options as part of the installation. This includes options such as display type, input device (either a keyboard or mouse), and printer options. You can select other tape hardware options for the DMA channel and interrupt through the menu software without hardware changes. It supports sharing DMA channels with other devices.

EmSave 1.21 provides a menu interface to the backup operations based on the Windows interface (a runtime version of Windows is shipped with the software). The software supports the basic features for backups and restores including unattended backup procedures. It also allows password protection of backups, creation of a script that backs up skipped files, duplication of tapes between two units, and redirecting of restored data to different directories or even different file names. Automatic backup files can be created by a learn mode that records the options and files selected through the normal menu interface.

Speed differences among the drives is due largely to differences in software, which greatly influence the device hardware.

The menu interface itself is quite good and a great improvement over Emerald's previous versions. Using a mouse to select options speeds up the process considerably; you also can use keystroke commands or a highlight-and-select scheme. The software has a quick display of the **savesets** (which are files backed up in one session) that were on a tape. This lets you choose the proper **saveset** from a list, after which the items for restoring are selected from a tree structure display of the **saveset** contents. Thus, files on the tape can be identified quickly for restore. The same type of tree structure can be displayed to select files for backup as well.

The software is versatile, but has some quirks. For example, in some places you press the space key to select items; in other places you press Enter. Also, when backing up or restoring data from the menus, you cannot save the default options for resetting the archive bits, handling Novell security information, and other features. If you want to use other default options, you must enter them each time you perform the operation. Another shortcoming is that this new software does not support the older-version tape formats for the company's ASP and EmSave software, so you must retain the old software to restore from old tapes.

The documentation is adequate and includes release notes that correct the original documentation for design changes. Despite the fact that a few changes are not documented (such as the time to erase a tape being two minutes—not four hours), the documentation is a useful supplement to the menu information. No required maintenance, however, is mentioned. In light of the fact that similar units (including the Maynard unit) occasionally require cleaning, it seemed natural that a cleaning kit and instructions would be forthcoming. Emerald plans to release a tape head-cleaning kit for the VAST drive in the second quarter of 1989.

The VAST Device offers high capacity and good software, and its speed is improved with the new software (although Maynard's drive ran faster). Emerald has a long track record, and the company has seen many problems with this unit resolved: Emerald has brought its product to a competitive position in the tape market. Those familiar with previous versions of this product should take a second look at a much improved package.

Maynard Electronics. The MaynStream 2200HS system is a top-quality package that offers a clean software interface along with good performance and high storage capacity. Although fairly new to the market, this unit shows real promise for the LAN environment. It includes a long list of features in addition to its solid core of standard backup system basics.

The 2200HS is an 8-mm, helical-scan cassette tape drive that holds as much as 2,200MB of data on a small tape cartridge. Although the drive itself is similar to Emerald's VAST Device, the packaging is quite different. The Maynard unit is designed to be portable; it uses a SCSI interface to transport data quickly from the PC to the tape drive.

Installing the hardware followed normal procedures. Hardware jumpers for the I/O address, interrupt, and DMA channel are set on the controller, which is installed in the PC system unit. Software installation is automated, and the hardware options did not need to be configured (the software detects them automatically).

The MaynStream software (version 2.3 SCSI) offers a nice list of extra features that are well-implemented. It permits the backup to wait for opened files to be closed before continuing; can create a script that backs up skipped files; protects tapes with passwords; excludes file specifications from backups; and can remove files after

they are archived. The software has a memory-resident program that allows backups to begin automatically at specified intervals. You can use either the pull-down menus or the command-line interface, which allows the features to be accessed by batch files and automatic response files. Using Ctrl-Enter to exit some menus takes some getting used to, but it is not a hindrance. Maynard's package includes an impressive and versatile set of software that is a pleasure to work with.

The documentation is also quite good. It includes both in-depth information and a good quick reference guide. (Be sure to read the part on network support. The software sees the current network directory as a virtual root directory. If the current directory on a network drive mapping is not the root directory (\), only the current directory and its subdirectories can be backed up.) The overall content reflects a well-designed system.

The package makes no suggestion of regular maintenance to the unit, but cautions owners not to use the 8-mm cleaning kits for video systems. They are advised to obtain a Maynard cleaning kit when it becomes available.

This product was impressive for both its capacity and its quality software. It performed equal to or better than other units in most of the tests. Maynard has delivered a first-rate product right out of the gate.

Mountain Computer. The Mountain 7300 is a dual-drive unit that supports two 150MB DC600 tapes. You can daisy-chain a second slave unit to the first drive to yield 600MB of capacity online. Although not outstanding in performance or features, this drive is well-implemented and a solid contender in the backup marketplace.

Installation went like most of the others, with one exception: the automatic software installation not only tested the drive but also detected the hardware options and configured the software to the corresponding settings. This helped in getting the system up and running quickly and easily.

The drive comes with version 4.5-MT of Mountain's Failsafe software. It provides both a menu and a command-line interface to the package's many options. In addition to the basic operations, files can be excluded from backups, tape passwords are supported, and several backups can be scheduled and executed using Mountain's Autorun option. You can generate a list of skipped files to ensure completeness during backup. Files for backup can be selected by marking them on a disk directory display in a highlight-and-select fashion. This software was very functional and easy to learn. Mountain's documentation is quite good, and the quick reference card provided is well-designed.

Mountain suggests that you clean the heads as needed due to excessive buildup on the tape head. Although this may not be necessary under normal operating procedures, standard cleaning cassettes can be used to remove excessive dirt.

Although not the fastest or highest capacity, this is a solid product. Although it was not available for this review, Mountain has announced a new unit based on the 8-mm, helical-scanning tape. Based on recent releases from Mountain, we can look forward to this addition to their line and anticipate a quality product.

HEAD TO HEAD

The speed differences among these drives is largely a result of differences in software. The design of the software not only dictates the user interface but also plays a major role in the speed of the unit. This market is still waiting for some top-quality software. In addition, when considering the cost of each unit, be sure to add the cost of tapes by estimating the size of the tape library to be maintained.

The ADIC Model 634 drive offers high reliability and error correction although it is slow and its software is awkward. The CORE 150/250 E offers a price and slight speed advantage in a portable unit, but has limited capacity and can stand improvements in its menu interface. The Emerald VAST Device offers very high capacity with reasonable speed and good software. The Mountain 7300 drive offers a solid drive at a competitive price but its abilities are not as outstanding by comparison with the others. The Maynard MaynStream unit stood out with its high capacity, good software, good speed, and knowledgeable technical support; it should do well.

A growing list of vendors now offer the Exabyte EXB-8200 in 2.2GB backup drives. These vendors include Palindrome, Performance Technology, Racet, Summis, and Tallgrass. Palindrome produces the Archive Librarian, which promises complete automation of the backup planning process and management of the tape library. Emerald is working on EMQ, Archive Server software that is to provide the Palindrome functions and allow users to submit jobs to the archive. Novell announced ambitious plans for an Archive Server in February 1989. Full automation of backup planning and logging will go a long way toward making LAN backup a background task.

The trade-offs among these drives are apparent. The point is to have adequate tape backup in place for your LAN. Tape systems are inherently less durable than the disk systems they are supposed to protect. They require cleaning, the drives break, tapes become tangled and break, and the drives are inordinately slow. But when the chips are down and a disk dies or a fire destroys your office, the worth of that $25 tape—with all your data on it—goes up immeasurably.

Bob Rufenacht works for a software development firm that specializes in LAN-based systems. He has been active in the microcomputer industry for five years.

Advanced Digital Information Corporation (ADIC)
14737 N.E. 87th Street
Redmond, WA 98073-2996
800/336-1233; 206/881-8004
Model 630 Data Library: $2,900
Model 634 Data Library: $3,900
CIRCLE 332 ON READER SERVICE CARD

CORE International
7171 N. Federal Highway
Boca Raton, FL 33431
407/997-6055
COREtape CT 150/250E: $2,295
CIRCLE 333 ON READER SERVICE CARD

Emerald Systems Corporation
4757 Morena Blvd.
San Diego, CA 92117
800/553-4030; 619/270-1994
VAST Device with Emsave 1.21: $7,995
RAMP Application Kit: $695
CIRCLE 334 ON READER SERVICE CARD

Maynard Electronics
460 E. Semoran Blvd.
Casselberry, FL 32707
800/821-8782; 407/331-6402
MaynStream 2200HS with version 2.3 SCSI: $6,995 (for PC); $7,095 (PS/2)
CIRCLE 335 ON READER SERVICE CARD

Mountain Computer Inc.
240 Hacienda Avenue
Campbell, CA 95008
800/458-0300; 408/379-4300
Mountain 7300 with Failsafe 4.5 MT: $3,395 (PC version); $3,495 (Micro Channel version)
CIRCLE 336 ON READER SERVICE CARD

The Micro Channel According to Tandy

DAVID CLAIBORNE

Two years after IBM PS/2s hit the market, the predicted flood of Micro Channel-compatible systems has not appeared. In a bid to attract corporate PC buyers, Tandy is first with its 5000 MC.

Given the remarkable success of the PC-compatibles marketplace, IBM's debut of the PS/2 two years ago this month set off a flurry of industry activity. The Tandy Corporation, one of the first to announce plans for a PS/2 compatible, seemed an unlikely candidate to lead what promised to be a major assault on the new PC territory. Tandy is known more for its success in retailing consumer electronics than its high-end computers.

The PS/2 compatibles were coming, we were told. Several dozen were expected by the end of 1988. Every major computer manufacturer (except Apple) was supposed to be working on one. The PC industry eagerly awaited the introduction of PS/2 compatibles at each new Comdex.

As 1988 came and went, however, the predicted flood of PS/2-compatible systems never quite materialized. Although IBM PS/2 models are selling well, many PC-compatible manufacturers have quietly scaled back plans to produce a PS/2 machine. Others promoted new AT-compatible architectures having some of the features of IBM's Micro Channel architecture—most notably, a form of multimastering.

On yet another tack, other companies retaliated by banding together with a mutual commitment to extend but preserve the PC/AT bus—and their shares of the PC-compatible market—as the industry standard. One group (which, incidentally, includes Tandy, as well as AST, Compaq, and Zenith) is formalizing the specification for an Extended Industry-standard Architecture (EISA) and is building prototypes to demonstrate the bus later this year.

Meanwhile, back at the ranch, Fort Worth-based Tandy pressed on and in September 1988, less than six months after its announcement, delivered the first PS/2 compatible, the Tandy 5000 MC. The 5000 MC is a desktop system designed not only to be compatible with the PS/2 Model 80, but also provide better performance.

The system, however, is still going through some growing pains. The operating-system software, for example, is based on software for Tandy's earlier 3000 and 4000 line of AT compatibles and still is in a state of flux. Physically, the system lacks the polish and snap-together design of an IBM PS/2; overall, it appears that the 5000 MC is more packaged than designed.

Indeed, Tandy has hesitated to call the 5000 MC a PS/2-compatible or even a Micro Channel-compatible machine. The "MC," for example, is not an abbreviation for Micro Channel as you might expect, but officially denotes "Micro Computer."

COMPUTER GRAPHIC • NATALIE/EAST

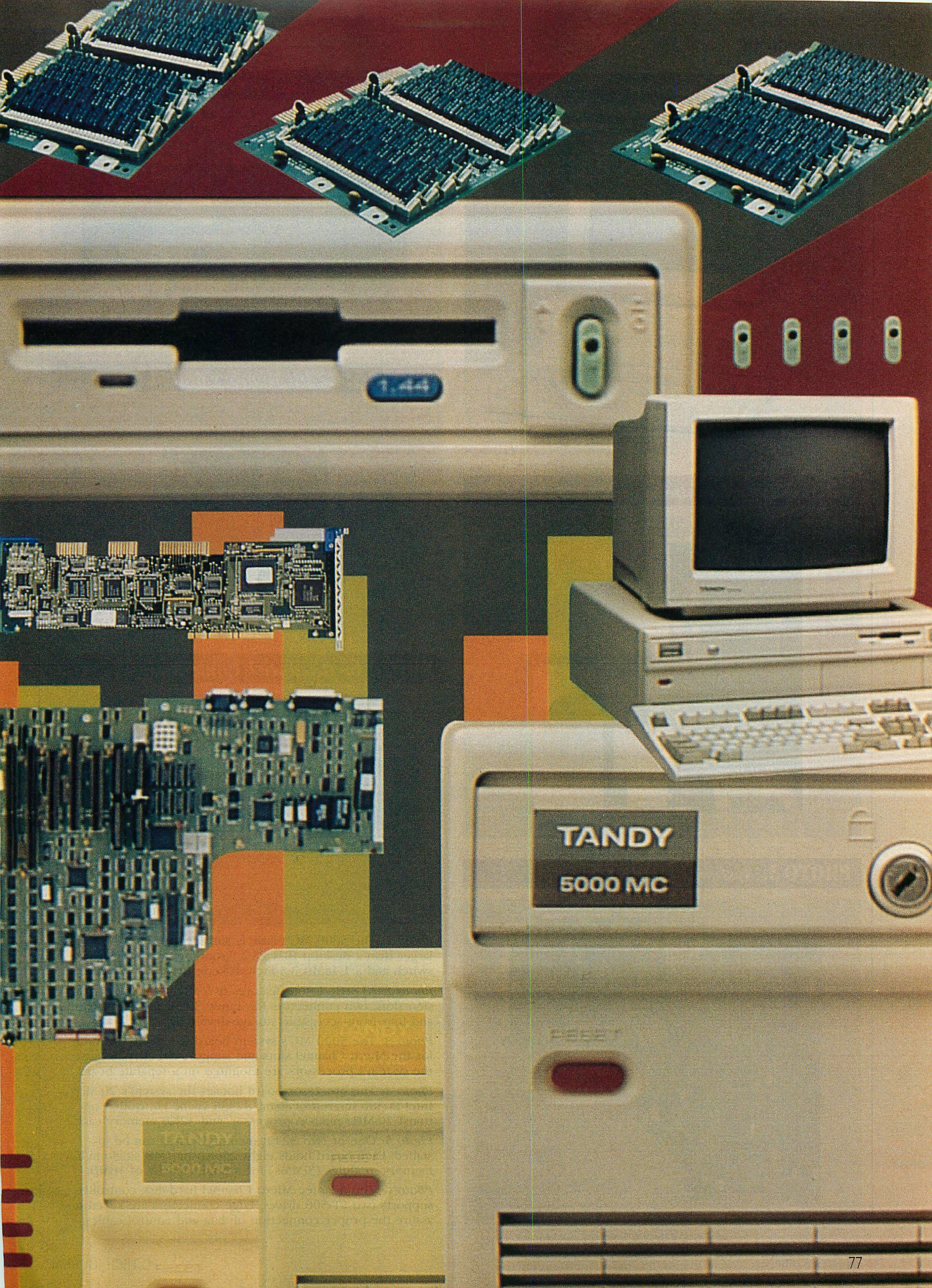

1.44
TANDY
5000 MC

PHOTO 1: ***Tandy 5000 MC***

PHOTO 2: ***Inside the System Unit***

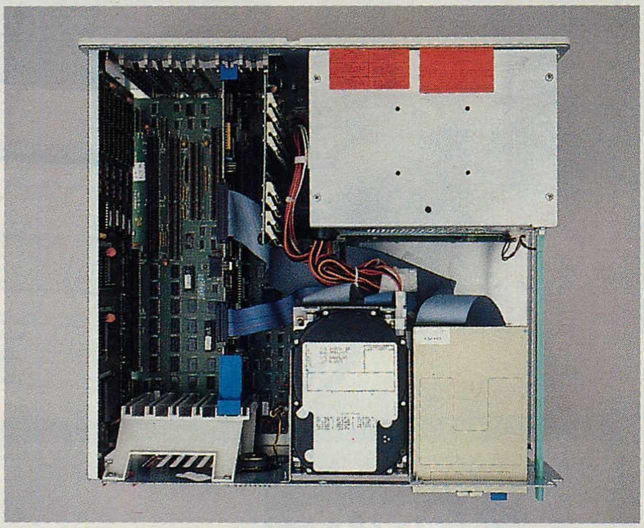


PHOTO 3: ***System Board***

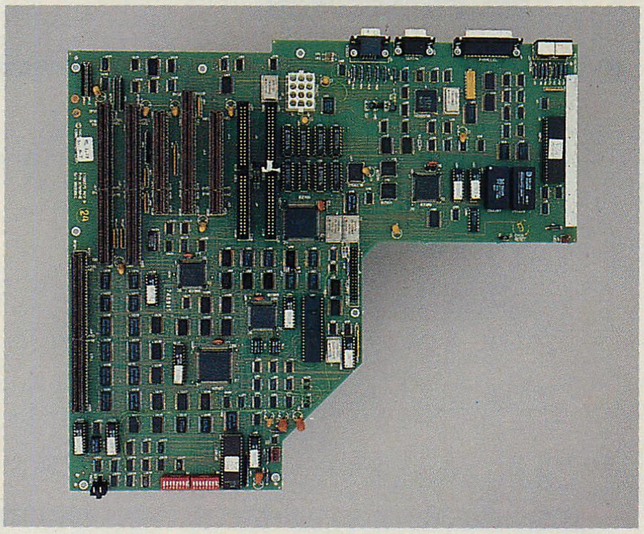


PHOTO 4: ***Processor Board***

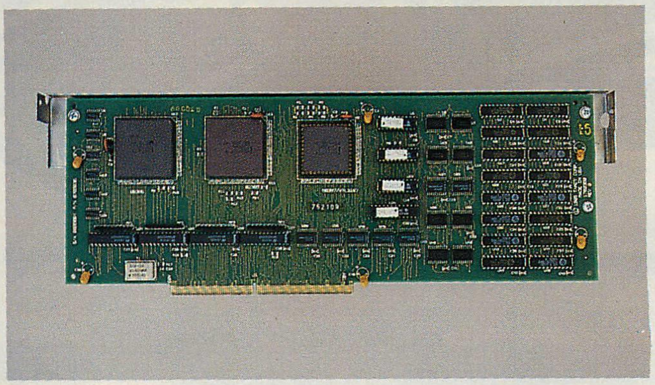


PHOTO 5: ***32-bit Memory Board***

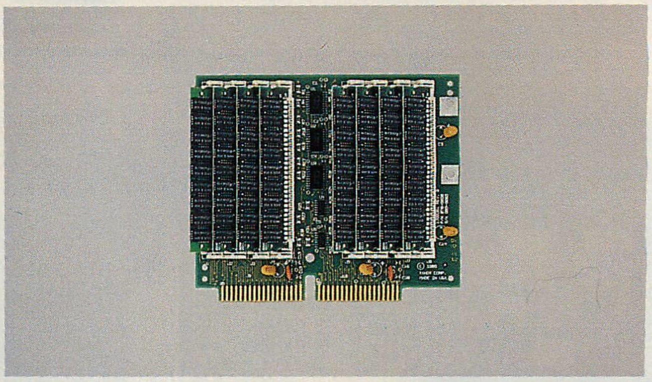


PHOTO 6: ***Hard-disk Controller***

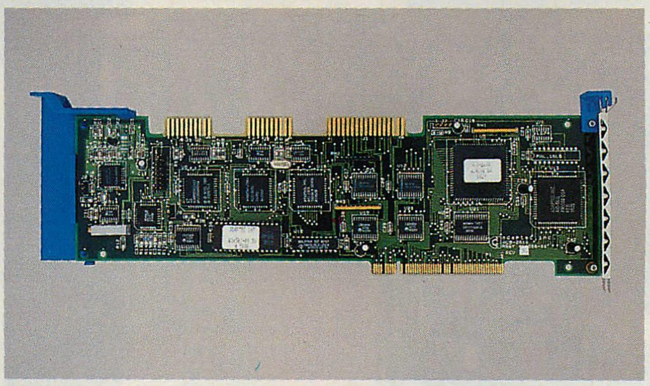


Photo 1: The 5000 MC's case is smaller than an AT's, but larger than a desktop IBM PS/2. Front-mounted power switch and a 1.44MB 3.5-inch diskette drive are standard.

Photo 2: AT-style layout features five Micro Channel expansion slots, two connectors for Tandy 32-bit memory boards, and four front-accessible storage-device bays.

Photo 3: The 5000 MC's system board has plenty of room for the Micro Channel slots and support circuitry because the system's processors are mounted on a separate board.

Photo 4: The processor board houses the system's 20-MHz Intel 80386 microprocessor, 82385 cache controller, optional 20-MHz math coprocessor, and 32KB memory cache.

Photo 5: One or two 32-bit memory boards can be installed. Each board holds eight 256KB or 1MB single in-line memory modules (SIMMs) for a total capacity of 16MB.

Photo 6: The Adaptec Micro Channel hard-disk controller supports two ST-506 drives. Edge connectors are keyed to assure the proper connection of data and control cables.

Whether the company is worried about potential future licensing problems or wants to distance the 5000 MC from the inevitable comparisons with IBM's PS/2 is now moot. With Micro Channel expansion slots, integrated VGA, and 32-bit memory, the 5000 MC is clearly a PS/2-compatible machine. *PC Tech Journal*'s compatibility tests confirm that the 5000 MC is Micro Channel compatible, with a few minor exceptions.

To be fair to Tandy, its entry into the PS/2-compatible market may be driven more by a well-coordinated plan to move into new business territories than by any direct challenge to the PS/2. Tandy clearly wants to change its Radio Shack image as a retailer of electronic parts to that of a high-tech corporation that is capable of attracting the attention of, among others, the corporate PC buyer.

Although Tandy has been making PCs since the late 1970s, industry compatibility has not been high on the company's list of priorities. More recently, as Tandy has turned its attention to the demands of the corporate market, its interest in industry compatibility is reaching an all-time high. Therefore, when Tandy announced the 5000 MC, it seemed to be the way the industry was heading. Tandy now finds itself on the cutting edge of new technology, or, depending on your perspective, caught in the limelight with a PS/2-compatible poised to go one-on-one with IBM.

PS/2, PARTNER?

Regardless of Tandy's intentions toward EISA, IBM, and the PC industry in general, the 5000 MC is a powerful personal computer. In the base configuration with 2MB of memory, 20-MHz Intel 80386 microprocessor, Intel 82385 memory-cache controller, 1.44MB 3.5-inch diskette drive, and built-in VGA, mouse, serial, and parallel ports, it is a lot of computer for a list price of only $4,999. Models that come equipped with 40 and 80MB hard disks list for $6,499 and $6,999, respectively (see the accompanying sidebar at right for more price information).

Almost any manufacturer, however, can make a 20-MHz (or even a 25-MHz) 386-based computer. The system's real claim to fame is located between a separate processor board and the memory board—five Micro Channel expansion slots—the first not inside an IBM PS/2.

The first two slots are the 32-bit variety. Slots 3, 4, and 5 support 16-bit adapters; slot 4 features the video-extension connector. Slot 5 generally holds a hard-disk controller, leaving four open slots eagerly awaiting Micro Channel expansion boards.

Whether Tandy actually planned it that way or because the 5000 MC is packaged in the same case as the 286-based 3000 system, the 5000 MC has a lot of elbow room inside. Not only does it have space for four storage devices (two 3.5-inch and two half-height 5.25-inch components), it also has room for the necessary data ribbon cables and power cables. Moreover, all four storage bays have external access. Because of all the room and external access, removing and installing storage devices is easily accomplished.

The system board supports two diskette drives and the optional ST-506 and enhanced small device interface (ESDI) hard-disk controllers, both of which control two drives each. A small computer system interface (SCSI) adapter that controls three internal SCSI disk or tape drives is also available. The 192-watt power supply has enough muscle to power the extra storage devices; two spare power-supply connectors are included.

Even with all this interior capacity, Tandy has managed to package the 5000 MC in a case that is somewhat smaller than the traditional AT (see photo 1). The case (6.25 inches high by 17 inches wide by 15.7 inches deep) is larger, however, than the sleek PS/2 desktop machines; with keyboard in place it will not fit on a 24-inch-deep work surface. Although the case is metal, the system is certified only for FCC Class A (commercial) use. Three Phillips-head screws secure the slide-off system cover.

The base unit has a 1.44MB 3.5-inch Sony diskette drive. The review unit included a 78MB Rigidyne hard disk in the other 3.5-inch bay. This arrangement still leaves room for a 5.25-inch diskette drive plus a tape drive.

The 5000 MC's keyboard is a definite improvement over previous Tandy keyboards. It features the standard IBM 101-key layout with the 12 function keys across the top. The keys provide both audible and tactile feedback when pressed, but the touch is lighter and quieter than on an IBM keyboard.

The front panel provides access to the standard 3.5-inch diskette drive. External access to the other bays can be gained by snapping off plastic cover panels. The push-button power switch, located in the upper right-hand corner, contains an embedded green LED to let you know the unit is on. Although the power switch is well recessed when the system is on, it is only an inch away from the button you push to eject disks from the 3.5-inch diskette drive. Casual disk ejection can result in inadvertent system shutdown.

The front-panel controls also include a mechanical cover lock and a reset switch, useful for rebooting the system when the keyboard locks. The reset switch is recessed and away from other controls so, unlike the power

TANDY 5000 MC VITAL STATISTICS

Base Model: $4,999
20-MHz Intel 80386 microprocessor
2MB interleaved 100-ns memory
32KB, 35-ns SRAM memory cache
Math coprocessor socket (Intel 80387 or Weitek 3167)
Realtime clock
Serial and parallel interfaces
Mouse interface
VGA interface
1.44MB 3.5-inch diskette drive
101-key enhanced keyboard

40MB Model: $6,499
All features of the base model except with a 40MB ST-506 hard disk

***80MB Model: $6,999**
All features of the base model except with an 80MB ST-506 hard disk

Options:
Memory-expansion board with 2MB (eight 256KB SIMMs): $1,398.00
Memory-expansion board with 8MB (eight 1MB SIMMs): $6,496.00
*Intel 80387 math coprocessor (20 MHz): $1,095.00
*Tandy VGM-300 VGA monitor with .31-mm dot pitch: $629.00
1.44MB 3.5-inch diskette drive: $279.95
1.2MB 5.25-inch diskette drive: $299.95
ESDI hard-disk drive controller: $429.95
140MB ESDI hard-disk drive: $1,999.00
SCSI adapter: $499.95
170MB SCSI hard-disk drive: $2,499.00
150MB SCSI backup tape drive: $1,299.00
MS-DOS/GW-BASIC 3.30: $119.95
MS-OS/2 Standard Edition 1.0: $325.00
Tandy 5000 MC Technical Reference Manual: $99.95

An asterisk indicates the model reviewed and the options included.

switch, it would be hard to press it by mistake. One useful item missing from the front panel is a hard-disk activity light; the Rigidyne hard-disk drive has the light, but it is hidden behind the system cover.

The back panel contains the full complement of connectors and ports expected on a Micro Channel machine. Both the mouse and keyboard ports are compatible with their IBM counterparts. The 5000 MC's serial port, however, uses an AT-style 9-pin D-shell connector rather than the PS/2-type 25-pin connector. The parallel port is a standard 25-pin connector and the VGA is a standard 15-pin connector. The back panel has six openings for access to expansion-board connectors.

TABLE 1: *Intel ASICs*

PART NUMBER	FUNCTION
82072	Diskette controller.
82306	Local channel-support controller; works with 82072 to control diskette drives.
82307	Direct memory access (DMA) and central arbitration control point; controls 8 DMA channels and provides arbitration for 16 devices, including bus masters.
82308	Micro Channel-bus controller.
82309	Address-bus controller; also interfaces the Micro Channel bus with the cache controller.
82706	VGA controller; interfaces processor to video memory, provides palette support, and displays video data.

Tandy uses application-specific integrated circuits (ASICs) from Intel Corporation to support the 5000 MC's diskette drives and control direct memory access (DMA), the Micro Channel bus, and the VGA video subsystem.

ROOM TO ROAM

Like its exterior appearance, the layout of the 5000 MC's interior is more like an AT than a PS/2 (see photo 2). The power supply is located in the right-rear corner, with a push-rod connection from the front panel to the power switch. The storage devices are clustered in the right-front section, connected to the rest of the computer with standard ribbon and power cables. The expansion slots occupy most of the left side of the machine.

Closer inspection reveals that the 5000 MC is not an AT-compatible, however. The expansion bus connectors have the tightly spaced connectors characteristic of Micro Channel (see photo 3). All the integrated circuits that need to run at 20 MHz are located on a processor board, stationed vertically on the left-most edge of the unit perpendicular to the system board and linked to the system board by a proprietary connector. The memory board uses another proprietary board and connector. Moreover, new types of Intel application-specific integrated circuit (ASIC) chips are sprinkled all around the system board.

Compared with a tightly packed PS/2 system board, the 5000 MC's system board has a lot of unused real estate because of Intel Micro Channel and VGA very large scale integration (VLSI) chip sets. The processors and their associated circuitry are on a separate board, and system memory is relegated to expansion boards. This open space is marred by an unusually large quantity of green jumper wires for a production model—Micro Channel compatibility may not be so easy.

The Intel ASICs are critical to the Tandy machine. Four chips (the 82306, 82307, 82308, and 82309) control the Micro Channel bus and provide the arbitration control needed to use bus masters. Two others, the 82072 and 82706, provide the circuitry for the diskette controller and the VGA display controller, respectively. Table 1 lists the Intel ASIC chips and their functions.

Other components on the system board include six socketed programmed array logic (PAL) integrated circuits, a ferrite bead at each external port to reduce radio-frequency emissions, 256KB of 120-nanosecond (ns) socketed video memory, five crystal oscillators for keyboard, display, and bus timing, and two new chips from Dallas Semiconductor hidden under the power supply.

One new chip, a DS1278A, contains a realtime clock, the RAM and logic needed to maintain clock information, and a lithium battery to keep it all ticking. The other, a DS1220Y, has the complementary metal-oxide semiconductor (CMOS) RAM required to maintain the machine setting and another built-in battery. Because of the integrated batteries, the 5000 MC does not require a separate battery. Dallas Semiconductor says the batteries will last for 10 years. When the batteries do give out, the chips are socketed for easy replacement (see photo 4).

Putting the processors on a separate board is a technique other computer manufacturers use, most notably Zenith in its Z-200 series. The advantage of this design is that the system can be upgraded by replacing only the processor board, leaving the rest of the computer intact. Based on the processor board's construction and components, Tandy clearly has this in mind.

The processor board contains the Intel 80386, the Intel 82385 memory-cache controller, a socket for a math coprocessor, a 40-MHz oscillator to drive the processors, 32KB of 35-ns static RAM cache memory, and four more Tandy PALs. The processors and PALs are socketed for easy replacement.

The 5000 MC accepts two types of socketed 20-MHz math coprocessors, the Intel 80387 or the Weitek 3167. According to the Tandy instructions, the processor board must be removed before installing the coprocessor. If the expansion slots are empty, however, it is easy to install the new chip with the board in place. Make sure that all the pins line up because a 20-MHz 80387 goes for about $500. A bent pin on a Weitek 3167 costs even more.

Like many 32-bit computer designers, Tandy has installed the bulk of system memory on two proprietary expansions boards (see photo 5). These boards and their unique bus increase performance in two important ways. First, all memory is arranged in bank pairs and operates in an interleaved page mode, which provides zero-wait-state access to locations within the same 2KB memory page. Second, all memory access to the bus is through a 32-bit, 20-MHz bus. This, coupled with the 82385 cache controller and 32KB static RAM (SRAM) memory cache, provides zero-wait-state access to memory more than 90 percent of the time.

Two Tandy proprietary memory slots occupy the right edge of the expansion bus (slots 6 and 7). The board in slot 7 is standard, with 2MB of 100-ns dynamic RAM (DRAM) installed in eight 256KB single in-line memory modules (SIMMs). Of this 2MB, only 1,664KB can be used directly; 128KB is used to shadow ROM, and the remaining 256KB is not accessible. To increase system memory, you can add a second memory board or replace the original

256KB SIMMs with 1MB SIMMs. Four memory configurations are possible using Tandy boards—2, 4, 8, or 16MB.

Installing memory on the Tandy board can be difficult. Slot 7 uses unconventional bracketing in its attachment to the case, making it difficult to remove. Moreover, in a notable departure from IBM's Micro Channel world, the 5000 MC cannot detect the amount of memory present on the Tandy memory boards; you must set two DIP switches and four jumpers on the system board to specify the type and amount of memory. The 5000 MC has no DIP- or jumper-setting diagrams inside the system unit to guide setup as is present in some other computers.

The disk controller is usually installed in the right-most Micro Channel slot to keep connecting-cable paths as simple as possible. The review unit featured a 76MB 3.5-inch hard disk and an Adaptec controller that controls two ST-506 drives (see photo 6).

STRAGGLING SOFTWARE

Although the 5000 MC is Tandy's state-of-the-art system, the system's software is a little behind the times. Tandy supplies optional MS-DOS and MS-OS/2 designed for the company's 3000 and 4000 series of computers. Not surprisingly, this leads to a few problems.

Although MS-DOS works without problems, Tandy's disk-caching program, CACHE, cannot find the extended memory on the system and loads in conventional memory below 640KB. CACHE could use expanded memory, but the Tandy expanded-memory manager (TEMM), which simulates expanded memory using extended memory, cannot find any extended memory to manage either. Tandy is working on 5000 MC-compatible replacements.

The original Tandy MS-OS/2, version 1.00.00, like Tandy's MS-DOS, is compatible with the Tandy 3000/4000 computers. Unlike MS-DOS, MS-OS/2 version 1.00.00 refuses to load at all on the 5000 MC. It displays its name and then locks out the keyboard while leaving the diskette drive running. A prerelease of version 1.00.01 (dated 10/11/88 and examined for this review) does allow MS-OS/2 to be installed on the 5000 MC. However, it is still version 1.00 of MS-OS/2—no Presentation Manager—and it works only with a serial port mouse. Apparently, Tandy does not yet have the drivers to make the system board mouse port work with MS-OS/2.

Like PS/2s, the 5000 MC comes with a reference diskette for setting up the system and configuring the Micro Channel expansion boards. Phoenix Technology developed the reference diskette software, which was updated three times during the initial months of production.

The reference diskette has an annoying quirk. According to the instructions, before using the diskette, you are supposed to make a backup using the BACKUP TRD DISKETTE command contained on the diskette. Unfortunately, this command works only if the backup diskette is a double-density, 720KB 3.5-inch diskette—even though the 5000 MC has a 1.44MB 3.5-inch diskette drive. Attempting to perform the backup using a high-density, 1.44MB diskette prompts the system to display an error message: "Disk Error – CRC error on read operation."

The Tandy documentation does not warn the user of this problem. Two solutions are available: buy double-density diskettes or use high-density diskettes and tape over the hole that indicates the diskette is high density. (The tape has to stay over the hole forever, so use good-quality tape.)

A feature missing from the reference diskette is system diagnostics. The IBM Reference Diskette contains an extensive set of diagnostics to assess system performance that comes in handy.

DANDY DOCUMENTATION

Tandy provides several forms of documentation with the 5000 MC. The manual that is included in the box is a short, 42-page pamphlet entitled *Tandy 5000 MC Installation and Operation Manual.* The pamphlet is professional, with a good layout, concise line drawings, and informative text. It is divided into hardware setup, system-unit operation, Reference Diskette instructions, and general information, index, and specification. The information is good, but little detail is provided.

Unfortunately, in the first edition of the manual, the DIP switch settings that determine the amount of internal memory (S2) are incorrect. Tandy has included a correction sheet with the manual. It is rather careless to misprint the only switch settings in the only manual. Tandy should have reprinted the manual.

Two volumes of slip-cased, looseleaf binder manuals were supplied with the evaluation unit. The volumes cover MS-DOS 3.3/GW-BASIC and MS-OS/2 1.0. Both volumes contain the standard information provided by Microsoft and then edited by Tandy. Both volumes, as well as the software they describe, are written for the Tandy 3000 and 4000 machines, not the 5000 MC.

The *Tandy 5000 MC Technical Reference Manual* provides a wealth of technical information. It includes theory of operation, circuit-board schematics and diagrams, timing diagrams, and parts lists. Tandy also included vendor information sheets on the Intel ASIC chips, the Dallas Semiconductor real-time clock chip, the Sony diskette drive, and a complete listing and explanation of the 5000 MC BIOS calls.

COMPATIBILITY CORRAL

IBM integrated many components onto the PS/2 system board that are not found on AT system boards (serial, parallel, mouse, and video ports, for example). Since the introduction of the AT in 1984, system-board memory has increased substantially. The PS/2s have several new capabilities, such as Micro Channel architecture, 32-bit expansion slots, and video extensions. For these reasons, *PC Tech Journal* has devised a new set of hardware compatibility tests for the Tandy 5000 MC and other PS/2 compatibles.

Six expansion boards are used to test the compatibility of Tandy's Micro Channel bus: two 32-bit IBM memory boards, Hayes and Intel 2400-bits-per-second (bps) internal modem boards, an IBM Token-Ring Adapter/A, and an IBM 8514/A Graphics Adapter. The memory boards test the ability of the bus to handle 32-bit memory. The two modem boards and the IBM Token-Ring Adapter verify bus operation with standard communication peripherals. The 8514/A verifies proper operation of the 5000 MC's Micro Channel video extension. A Microsoft serial mouse and IBM PS/2 mouse verify the operation of the system-board ports.

All boards install easily into the 5000 MC, configure without problem using the Tandy reference-disk configuration program, and, with minor exceptions, perform as expected. Both the Microsoft serial mouse and the IBM PS/2 mouse perform correctly. Table 2

TABLE 2: ***Micro Channel Adapter Compatibility***

BOARD DESCRIPTION	BUS WIDTH (bits)	COMPATIBLE
IBM 2-6MB Memory Board	32	●
IBM 2-8MB Memory Board	32	○
Hayes 2400P Modem	16	●
Intel 2400B Modem	16	●
IBM 8514/A Graphics Adapter	16[a]	●[b]
IBM Token-Ring Adapter	16	●

● = Yes ○ = No

[a] The 8514/A Graphics Adapter requires a 16-bit Micro Channel connector with video extension.
[b] Initializes in monochrome rather than color mode.

The Tandy 5000 MC works with all the Micro Channel boards tested except the IBM 2-8MB 32-bit memory board. Extra software initialization steps are required, however, when the 5000 MC is using the 8514/A graphics adapter.

summarizes the results. The Tandy bus is a functional and compatible Micro Channel bus.

One exception is the IBM 2-8MB memory board. This board cannot be used with the 5000 MC because it works only with a version of IBM's SC.EXE configuration program, which is not compatible with the Tandy machine. The IBM 8514/A video adapter works with the 5000 MC; however, if the only display on the system is connected to the 8514/A video connector, the 5000 MC initializes the video system in monochrome mode. The system can be set to color mode with MODE CO80 in the AUTOEXEC.BAT file, but the problem would not occur at all had Tandy been more careful in their design and testing phases.

The hardware compatibility of the Tandy 5000 MC was tested further by using the IBM Model 70/80 Reference Diskette to run system diagnostics. The 5000 MC passed all diagnostics except the memory and mouse-port tests. The failure of the memory test is understandable because the 5000 MC uses a different memory architecture. The mouse-port failure is curious, however, because the IBM mouse seems to work fine with the Tandy mouse port.

Tandy 5000 MC software compatibility was tested using the same software packages used in AT-compatibility trials. The software includes Microsoft Word and Windows/386, Living Videotext's Ready!, Datastorm Technologies' PROCOMM PLUS, Fifth Generation's Fastback Plus, and Borland's Lightning, SideKick, and SuperKey. To evaluate the OS/2 capabilities of the system, all programs except Windows/386 were tested in the DOS compatibility box.

Proper operation of Word verified the 5000 MC's mouse interface, as did Windows/386. Windows/386 also demonstrated the 5000 MC's ability to operate in the virtual 8086 mode and use extended memory. The terminate-and-stay resident (TSR) programs (Lightning, SideKick, SuperKey, and Ready!) all functioned normally, but because no expanded memory could be designated in the Tandy memory, Ready! used only conventional memory. Fastback Plus indicated proper operation of direct memory access (DMA). PROCOMM PLUS exercised both modems over the Micro Channel bus with no problems. Program operation was normal under DOS and in the DOS-compatibility box under OS/2 for all programs.

The final compatibility test run on the 5000 MC was the *PC Tech Journal* VGA compatibility test suite (see "The

VGA Compatibility Test," Ed McNierney and Kent Quirk, November 1988, p. 49). The on-board VGA controller passed 14 of the 18 VGA compatibility tests. The failures were minor. In the test of BIOS text I/O, the 5000 MC had improper characters in mode 11H. In the test of BIOS palette/digital-to-analog (D/A) converter, the color-page select, one of 16 subfunctions returned an improper value. Two reserved bits in the general-register set's input-status register zero are set to zero rather than one. Cursor-start and cursor-end values differed from IBM values in modes 00, 01, and 02 in the test of the CRT controller registers.

Overall system performance was tested using *PC Tech Journal*'s high-level benchmarks (see "High-level Measurements," Kent Quirk, September 1988, p. 54). The 5000 MC's test results (see table 3) are comparable to other 20-MHz 80386 computers, with and without Micro Channel compatibility. As an excursion, the full test set was run in the OS/2 DOS compatibility box; performance was unchanged.

The 5000 MC's CPU/memory and floating-point performance is 20-percent faster than the IBM PS/2 Model 80 and is comparable to the Compaq Deskpro 386/20 except in video performance. Neither the Tandy nor IBM machine can match the Compaq's 16-bit VGA performance (see figure 1).

TABLE 3: *Benchmark Results*

	IBM PS/2 MODEL 80	COMPAQ DESKPRO 386/20	TANDY 5000 MC
EQUIPMENT			
BIOS date	10/07/87	1/28/88	07/29/88
Processor speed (MHz)	20	20	20
Coprocessor speed (MHz)	20	20	20
Base memory size (MB)	2	1	2
Video controller	8-bit VGA	16-bit VGA	8-bit VGA
Hard-disk size (MB)	115	300	78
HLTEXT (text scrolling)			
BIOS	9.50	3.95	10.98
DOS	10.93	4.94	11.92
C library	9.34	4.12	11.26
Windowed	3.18	1.75	3.84
Total	33.57	14.78	38.02
HLWINDOW (windows/scrolling)			
Total	5.65	2.80	6.59
HLGRAPH (16-color graphics)			
400 small areas	4.12	3.68	4.39
100 large areas	3.18	2.58	3.40
400 small ellipses	4.06	2.91	3.24
200 large ellipses	3.84	2.69	3.02
4,000 short lines	3.40	2.41	2.74
2,000 long lines	3.18	2.19	2.52
General graphs	0.76	0.60	0.60
Total	22.58	17.08	19.94
HLSORT (CPU/memory)			
Data generation	0.76	0.65	0.65
Memory sort	9.12	7.08	7.08
Total	9.89	7.74	7.74
HLFLOAT (Fast Fourier Transform)			
Forward	3.73	3.24	3.29
Reverse	3.79	3.24	3.35
Total	7.52	6.48	6.64
HLDISK (with disk cache)[a]			
Data file creation	2.96	2.96	3.07
Index file creation	18.95	15.71	14.17
First report generation	1.31	1.26	1.09
Data reorganization	3.90	3.46	3.79
Second report generation	1.15	0.76	0.81
Total	28.35	24.12	22.96
HLDISK (without disk cache)			
Data file creation	3.02	2.96	3.07
Index file creation	30.76	22.58	26.04
First report generation	11.53	5.98	10.00
Data reorganization	15.93	9.72	13.62
Second report generation	3.35	0.76	3.13
Total	64.67	42.08	55.98

All times are in seconds, coverted from 18.2-HZ timer ticks; therefore, total displayed is not always the exact sum of the individual results displayed.

[a] The disk-cache size is 256KB. The IBM and Compaq caches are located in expanded memory. The Tandy cache is in conventional memory.

The Tandy 5000 MC's video performance is similar to that of the IBM PS/2 Model 80, but it is no match for the Deskpro 386/20 with its 16-bit VGA. CPU/memory and floating-point performance are equal to that of the Deskpro 386/20, making the 5000 MC 20-percent faster than the PS/2 Model 80.

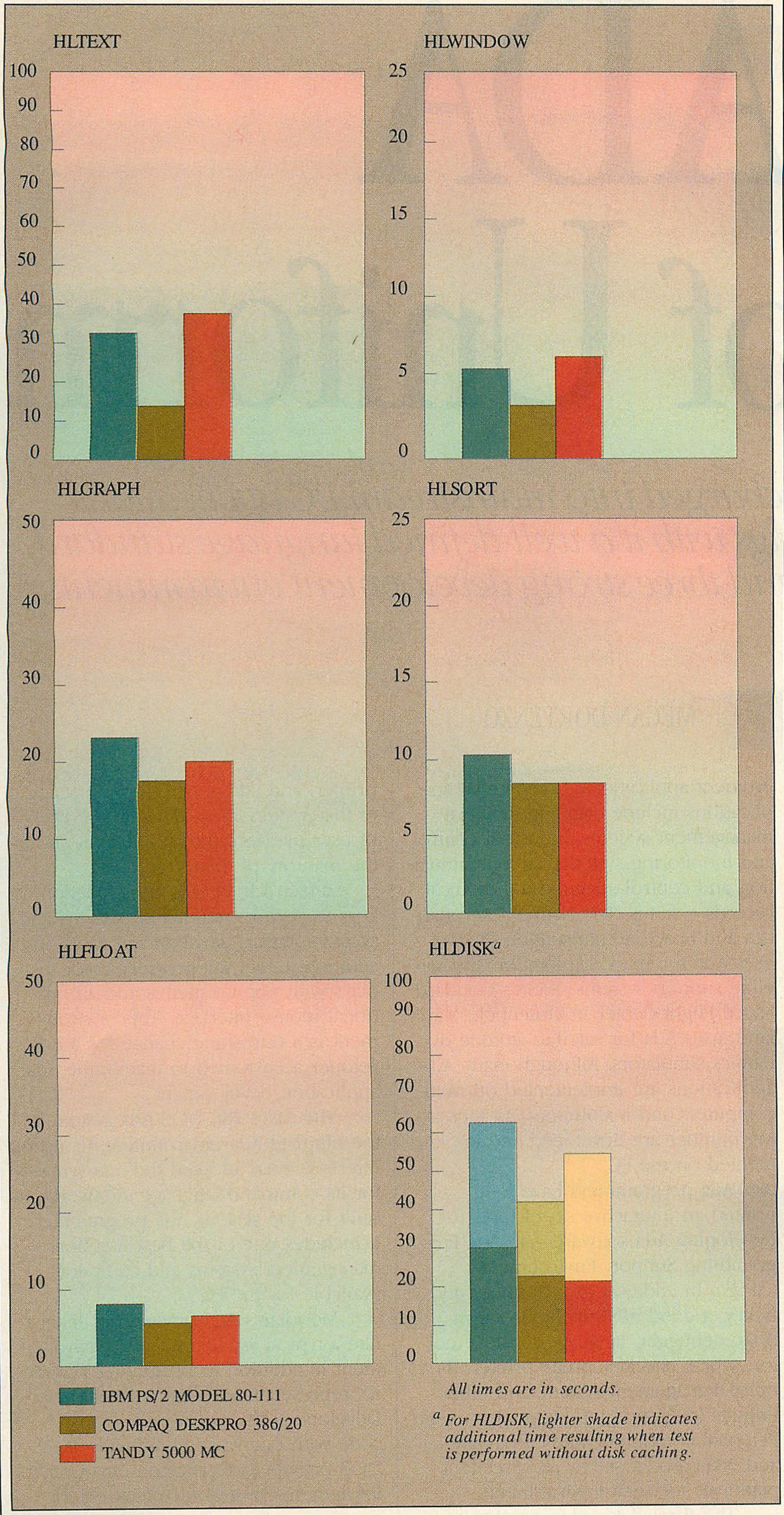
A TRAILBLAZING MACHINE

One way to sell an IBM compatible is to offer a comparable product for less money. Considering IBM's profit margin, this may be one of the more popular marketing techniques. Another way is to offer a superior product at a comparable price. With the 5000 MC, Tandy is covering all bases.

The 5000 MC's performance is comparable or superior to the 20-MHz PS/2s and offers a high degree of compatibility. Its on-board VGA controller is compatible with the VGA standard and its Micro Channel bus is compatible with the IBM standard. The machine also is compatible with Tandy's version of MS-OS/2. Moreover, it accommodates four internal storage devices, 16MB of 32-bit memory on a 20-MHz bus, and five Micro Channel slots, all the while maintaining a reasonable, desktop size.

The 5000 MC is priced attractively compared with the floor-standing PS/2 Model 80, but less so compared with the desktop PS/2 Model 70. A 20-MHz IBM PS/2 Model 80-111 with 2MB of RAM, 115MB hard disk, and VGA color

FIGURE 1: *Performance Comparison*



The Tandy 5000 MC's 76MB ST-506 hard-disk drive is faster than the IBM PS/2 Model 80's 115MB enhanced small device interface (ESDI) hard-disk drive with or without disk caching. When a 256KB disk cache is used, it performs the HLDISK test as fast as the Compaq Deskpro 386/20's 300MB ESDI hard-disk drive.

display lists for $9,745. A comparably equipped PS/2 Model 70-121 lists for $8,745. The 5000 MC goes for $8,057 and delivers performance comparable to the Compaq Deskpro 386/20e, which lists for $9,497.

Tandy's machine, however, suffers from imperfections not found in an IBM- or Compaq-class machine—the location of the power switch, the lack of a hard-disk indicator light, and DIP switches required to configure memory, to name a few. The number of jumper wires on the system board does not convey confidence, especially in a machine announced last April that has been shipping since September.

The software compatibility problems with Tandy's own software also tarnishes the professional image Tandy is seeking to promote. The lack of an operable extended-memory manager and extended/expanded-memory disk-cache program 12 months after the product announcement is not inspiring. Issuing monthly updates to the Reference Diskette, while correcting problems, also erodes confidence.

Despite these problems, the Tandy 5000 MC is a landmark machine for Tandy in particular and the PC industry in general. The 5000 MC is now the proving ground for several other companies that have a stake in the future of a PS/2-compatible market. It is a statement that the 5000 MC's Phoenix Technology Advanced 386 BIOS is compatible with Micro Channel expansion boards running under both MS-DOS and MS-OS/2. The machine is also a statement by Intel that its Micro Channel and VGA ASIC chip sets, which form the backbone of the 5000 MC, work in a production computer.

Whether or not Tandy's Micro Channel machine will blaze a trail to the doors of corporate America remains to be seen. As a first step in Tandy's plan, however, the 5000 MC demonstrates the company's ability to design and produce a sophisticated system that can match the best the industry has to offer.

Tandy Corporation
1800 One Tandy Center
Fort Worth, TX 76102
817/390-3700
5000 MC: prices for various configurations are given in the sidebar on page 79

CIRCLE 331 ON READER SERVICE CARD

David Claiborne is a technical manager for JAYCOR in Edgewood, Maryland, and a contributing editor to PC Tech Journal.

ADA Out of Uniform

Now honorably discharged into mainstream PC applications development, Ada brings with it a well-defined language standard, superior portability, and three strong development environments.

MEGAN DORTENZO

Software developers do not have to don fatigues to program in Ada, just their PCs, now that Ada has been ported to the desktop in some worthy packages. Originally conceived for military purposes, Ada is bound to find a home in many nonmilitary applications. The business world is now discovering the software engineering attributes and portability features that make it so appealing to the defense community. Reliable, maintainable, portable software is often as important for a dynamic economic model as it is for a fire-control system.

Three current Ada environments for the PC are IntegrAda from AETECH, AdaWorld from Alsys, and AdaVantage from Meridian Software Systems. The performance of the Ada environments is considered here in terms of the ease and flexibility of taking Ada software through all phases of the development life cycle. Compiler performance is assessed using the Performance Issues Working Group (PIWG) Ada compilation tests. PIWG is a subsidiary of the Special Interest Group on Ada (SIGAda) of the Association of Computing Machinery (ACM).

In addition to military command and control systems, Ada is used in many commercial and nonmilitary government applications. Commercial applications include data and financial management systems, industrial control and monitoring systems, aircraft simulation and control systems, and medical records systems. The National Aeronautics and Space Administration (NASA) uses Ada for space exploration and satellite support systems. NASA's Goddard Space Flight Center in Greenbelt, Maryland, uses Ada for satellite attitude dynamics simulators. Although many Ada applications are implemented on minicomputers and mainframes, an increasing number are developed and implemented on the PC.

Ada programmers have long wanted an interactive set of tools for developing Ada software—an Ada Programming Support Environment (APSE). In addition to a compiler and linker, a good APSE includes a symbolic debugger, language-sensitive editor, syntax checker, pretty printer, library-management system, and other utilities integrated into an environment. Personal computers, particularly 286- and 386-based systems, are excellent platforms for such environments.

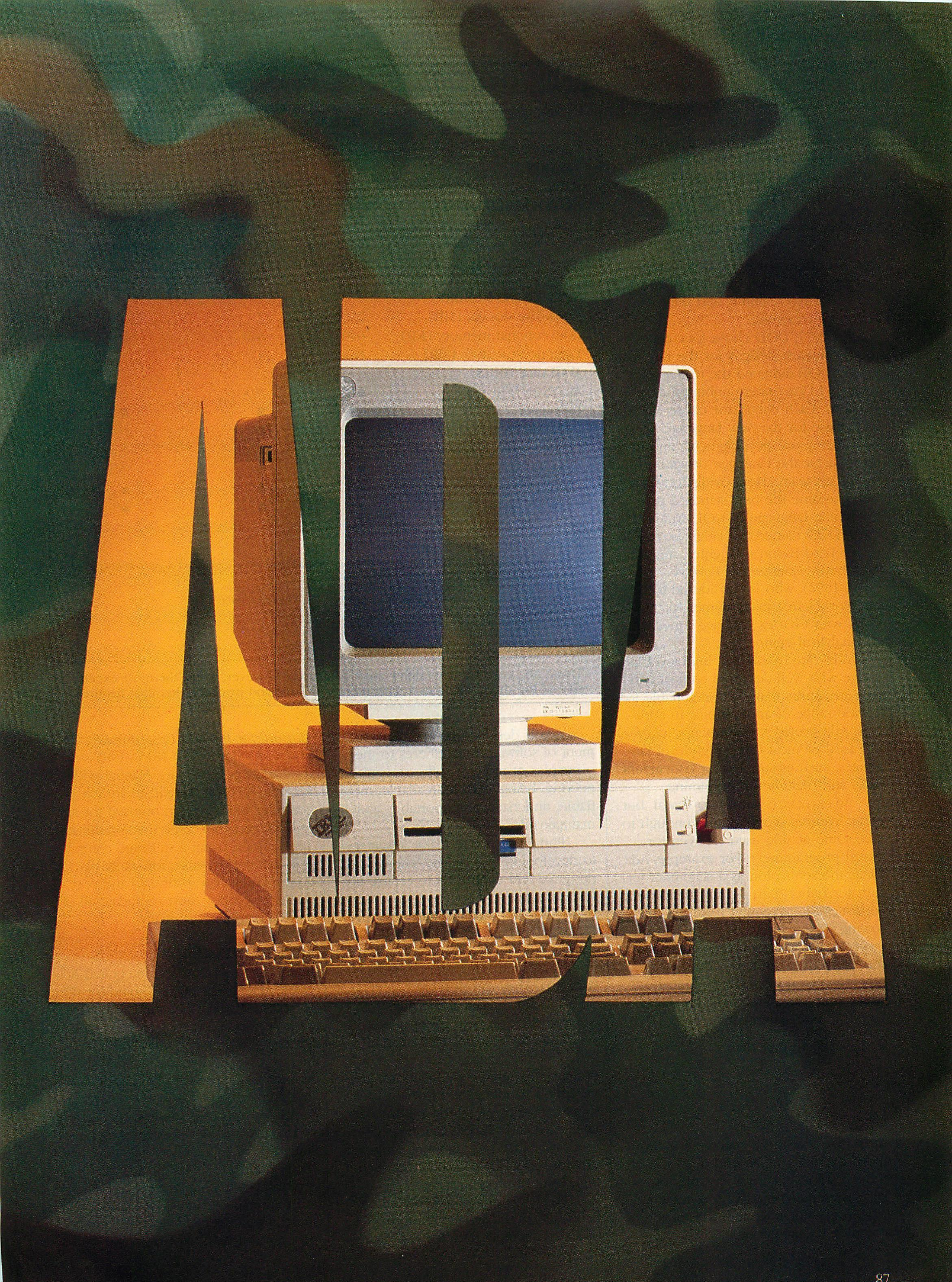
The three Ada environments reviewed provide similar basic functionality; that is, each has a compiler, linker, some level of optimization, pretty printer, and additional utilities specific to that system. They differ in the type of user interface they implement and in the maturity of their compilers.

AETECH's IntegrAda uses function keys to perform editing operations and access software development tools. In addition, IntegrAda provides color displays with pop-up menus and an optional mouse interface. This environment is a refreshing change for a developer accustomed to mainframe Ada application development.

The Alsys 286 DOS Ada system is the ultimate Ada environment. Its user interface even adopted the Ada syntax for its command language. AdaWorld is built for the serious Ada programmer; it includes one of the best Ada library-management systems and compilers available for the PC.

Meridian's AdaVantage can behave like a typical mainframe Ada environment in addition to presenting a graphics representation of its environment. Developers can invoke Ada source code with one-word commands at the DOS prompt. AdaVantage's environment implements several nice features for developing Ada software. Principal among these is the representation of all compilation units of an Ada program in a matrix organization.

PHOTOGRAPHY • BRUCE WELLER


ADA

WHY ADA?

In the 1970s, the United States Department of Defense (DOD) and the North Atlantic Treaty Organization (NATO) jointly undertook to develop a standardized programming language for all "mission critical" systems. Studies had shown that DOD spent large amounts of money on various software applications, about 50 percent of which were embedded systems. An *embedded system* is one in which the host computer is a part of a larger system and typically requires realtime, and often concurrent, processing.

In 1977, DOD chose four contractors to suggest designs for the new language. DOD assigned the teams color codings to encourage unbiased comparisons. Each contractor chose Pascal as its base for the new language.

After more developments and interim steps, the language designed by the green team (Honeywell/Honeywell Bull) became the new standard programming language of DOD in May 1979. DOD named the language Ada to honor Lord Byron's daughter, Augusta Ada Byron, Countess of Lovelace (1815-1852), who is considered to be the world's first programmer for her work with Charles Babbage's mechanical analytical engine.

Ada, like Pascal, is a high-level language with well-designed control and data structures that make it suitable for a wide range of applications. In addition, Ada provides features not inherent to Pascal or most other high-level languages, such as support for concurrent tasks and realtime programming.

Ada syntax is similar to Pascal, but some features are dissimilar enough to take some getting used to, even for Pascal programmers. For example, Ada treats the semicolon as a statement terminator rather than as punctuation that separates the statement from the following statement. Thus, the Ada code example below requires a semicolon to terminate the statement **Count := 0**, whereas Pascal would not require one to separate the assignment statement from the **else** statement:

```
if Time = End_Time then
   Count := 0;
else
   Count := Count + 1;
end if;
```

Also, note that the if statement is terminated explicitly by an **end if**, which, although somewhat cumbersome for such a simple comparison statement, aids in the documentation of more complex **if** statements.

TABLE 1: *Environment Specifications*

	AETECH	ALSYS	MERIDIAN
PRODUCT	IntegrAda	286 DOS Ada	AdaVantage
VERSION	4.10	4.2	2.2E
PRICE	$795	$3,595[a]	$1,780
SYSTEM REQUIREMENTS			
System compatibility	PC	AT	PC
Coprocessor	Optional	80287/8087	Optional
Operating system	DOS 2.0	DOS 3.0 and DOS Linker 2.3	DOS 2.1
STORAGE AND MEMORY			
Hard-disk storage (MB)	2	7	2
Conventional memory (KB)	640	640	640
Extended memory (MB)	None	4	None[b]
AVAILABLE TOOLS			
ALSYS INTERFACE	●	N/A	○[d]
Debugger	○[c]	●	●
DYNAMIC ANALYZER	●	○	○
Cross-reference generator	●	●	○
Make utility	●	●	○
Optimizer	●[e]	●[e]	●
Pretty printer	●[f]	●	●[e]

● = Yes ○ = No N/A = Not applicable

[a] Price includes a 4MB RAM board; required one-year maintenance agreement is an additional $360.
[b] Extended-mode compiler requires 1MB of memory.
[c] Includes Interface and Periscope symbolic debugger.
[d] Implemented using compiler and linker options; not a separate utility.
[e] Included with basic system.
[f] More powerful than one provided with basic system.

These Ada environments differ greatly in price; however, Alsys, the most expensive of the three, includes a 4MB memory board and provides the most features.

Ada is designed for the development of software that adheres to the principles of modern software engineering: being reliable, readable, modifiable, understandable, portable, and maintainable.

Portability is one major advantage to developing in Ada. The language is designed and controlled to ensure uniform execution of source code on multiple computer systems, and now this list includes PCs. Programmers do not have to wait for free time on mainframes and minicomputers to work with Ada. They can develop Ada code on a PC and transfer it to a mainframe or another PC later, if necessary.

Ada also provides well-defined language features that assist in the development of source code: generics, tasks, exception handling, and low-level features consisting of interfacing to other languages and representation specifications. No other programming language provides all of these features at such a high level of programming.

The DOD Ada Joint Program Office (AJPO) validates the conformance of all Ada compilers to the *Reference Manual for the Ada Programming Language*, ANSI/MIL-STD-1815A-1983—the Language Reference Manual (LRM) for Ada. AJPO must validate an Ada compiler before it can be used for any military program. Even for nonmilitary applications, using a validated compiler is worth the expense, for standards conformance, compatibility, and portability. A vendor must revalidate all of its Ada compilers annually.

AETECH INTEGRADA

IntegrAda is a complete, integrated Ada environment that is well suited for the PC world. Its user interface is modeled after popular PC packages, and takes advantage of color monitors, pop-up menus, even a mouse interface—the first for an Ada environment. Another first is that IntegrAda is written entirely in Ada. AETECH uses the current version of IntegrAda to develop new versions. IntegrAda is an excellent Ada environment at $795.

IntegrAda's hardware requirements are minimal (see table 1). The host PC must have an 8086-compatible microprocessor, a 2MB hard disk, and 640KB

of RAM. An 8087 math coprocessor is optional; if the system does not have one, a software floating-point implementation is available. A linker option informs the system whether to access the hardware or software implementation. A Microsoft Mouse (or compatible) is optional.

Compiler. AETECH uses a licensed version of R. R. Software Inc.'s Janus Ada compiler as the foundation for the Integrada compiler. AETECH enhances and revises the compiler in order to adapt it into the IntegrAda development environment. The developer invokes the IntegrAda compiler from within the IntegrAda environment or from the DOS prompt. When executing from within the IntegrAda environment, two separate commands are available.

Table 2 lists compiler options. These options include establishing a virtual disk to improve compilation and binding times, indicating whether to access the software or hardware floating-point implementation, accessing the debugger, and controlling the amount of detail in error and warning messages (see photo 1). Optimization of the code is handled among three options: one turns the optimizer on or off, another controls the removal of unused subprograms, and a third optimizes the code for execution on your specific microprocessor.

It appears as though AETECH includes fewer options than Alsys or Meridian, but IntegrAda does provide these options, as Ada pragmas placed in the source code. A pragma is an Ada construct that conveys information to the compiler. For example, Ada pragmas can suppress runtime error checks (pragma Suppress), indicate that a subprogram is written in another langauge (pragama Interface), or specify the minimum storage size to be allocated to a given type (pragma Pack). Some of the IntegrAda pragmas control the text format of the generated listing files or the suppression of runtime checks.

To some degree, IntegrAda implements the majority of Ada's low-level features and Ada's LRM Chapter 13 features (see table 3). Pragmas Pack, In-Line, and Suppress are implemented. In addition, pragma Interface is implemented for Microsoft Assembly Language (MASM) programs. The address clause is supported for segmented addressing through types and operators defined in the package System. Interrupt entries are partially supported through the predefined IntegrAda packages Bit, Byte, and DOS. Both generic subprograms Unchecked_Dealloca-

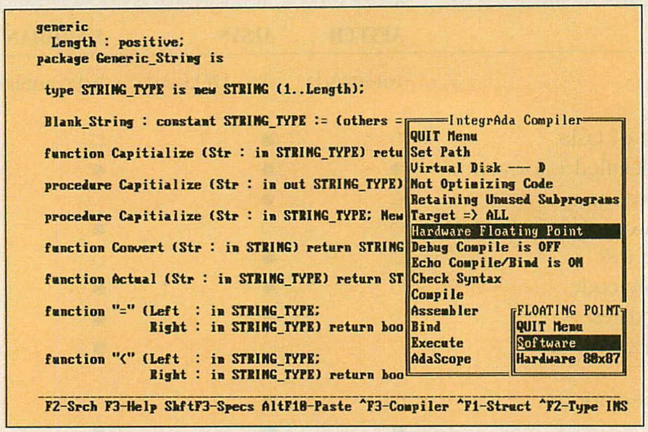
TABLE 2: *Compiler and Linker Features*

	AETECH	ALSYS	MERIDIAN
PRODUCT	IntegrAda	286 DOS Ada	AdaVantage
COMPILER			
Allow declaration of tasks	○	●	○
Compile giving detailed information	●	●	●
Control data allocation	○	●	○
Emit exception location information	○	○	●
Generate generic inst	○	●	○
Generate assembly code	○	●	●
Inhibit library updates	○	●	●
Inhibit stat initialization of variables	○	○	●
Limit number of errors	○	●	○
List errors	●	●	●
Listing file format	○	●	○
Optimization options	●	●	●
Produce listing file	●	●	●
Provide description	○	●	○
Save debugger information	●	●	●
Save tree representation	○	●	○
Set virtual-memory size	○	●	○
Set stack- and global-object size	○	●	○
Specify library	○	●	●
Suppress warnings	●	●	●
Suppress checks	○	●	●
Use additional 8086/8088 instructions	○	○	●
Interact after errors	●	○	○
LINKER			
Debugger	●	●	●
Link giving detailed information	●	●	●
Optimization options	●	●	●
Produce relinkable output	○	○	●
Set task stack size	○	●	●
Set program stack size	○	●	●
Set timeslice for tasks or synchronous tasking	○	●	○
Set trace on calls for exceptions	○	●	○
Specify timer to be used	○	●	○
Specify scratch files	○	○	●
Specify floating-point implementation	●	○	●
Specify targeted execution mode	○	●	●
Specify compiler	○	○	●
Specify executable name	○	○	●
Specify library	○	●	●
Specify location/names of created binary files	○	●	○
Specify location/names of external modules	○	●	○
Spe^ify incremental heap allocation sizes	○	●	○
Specify heap size	○	●	○
Suppress warnings	○	●	○
Verify link	○	●	●
Produce map file	○	●	●
Interact after errors	●	○	○

● = *Yes* ○ = *No*

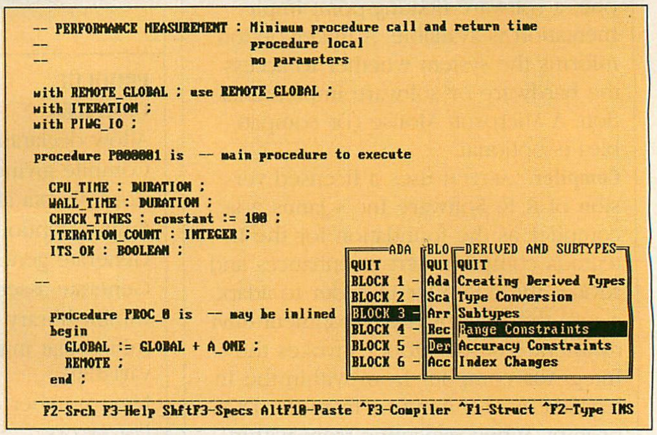
AETECH's IntegrAda provides fewer explicit compiler options than the Alsys or Meridian packages; however, many of the same facilities are included in IntegrAda as Ada pragmas that can be placed in program source code.

PHOTO 1: ***IntegrAda User Interface***



IntegrAda's integrated Ada environment lets the developer edit, compile, and run applications from a central menu; you select compile and bind options via pop-up menus.

PHOTO 2: ***IntegrAda Lesson Window***



In IntegrAda, tutorial and help information about Ada can be displayed on-line while the developer edits a file; the topic selected here is data string range constraints.

tion and Unchecked_Conversion are available. The Size and Small length clauses are implemented and the Storage_Size clause is allowed for all task types; representation specifications are implemented for enumeration types, but not for records.

Although IntegrAda supports the pragma Interface for MASM subprograms, a separate Assembler utility is available. The assembler provides a flexible, Ada-oriented approach to interfacing with assembly language; however, its impact on portability must be considered. Because this is a unique mechanism for interfacing with assembly language, changes will have to be made to ensure compatibility when transferring Ada source code to another host environment.

The IntegrAda compiler limits Ada source code in several ways. The maximum code size for a single compilation unit is 32,000 bytes, as is the maximum size of all the constants in a compilation unit. A program can consist of a maximum of 300 compilation units, and it can have 7 pending floating-point subexpressions.

Library management. IntegrAda was developed for the PC and was modeled after current PC development systems. This is apparent in two areas: the style of the user interface and the lack of library management. As with the many PC compilers, IntegrAda locates all generated binary and listing files in the default subdirectory.

Most Ada systems on mainframes, minis, and PCs provide some mechanism for maintaining binary files in one or more separate libraries and for controlling the visibility of those libraries. This feature is valuable because Ada programs tend to be modular and consist of numerous source files. Managing all of these source files during development is challenging, not to mention managing the multiple binary files associated with each source file. A library-management system greatly simplifies this task.

Although the IntegrAda system does not provide commands for managing and controlling Ada libraries, manual means are available. When you invoke the IntegrAda compiler or binder, the system first searches the current directory for all necessary object code. If more files are needed to complete the operation, then the system follows the DOS path to find the necessary object code. Thus, the developer must move the binary files to other directories and set the path directive to point to those directories.

This method of managing libraries can be annoying especially to an Ada programmer. It is not user-friendly to expect the programmer to manage the location of library files. Also, the use of multiple libraries is not possible without constantly changing the path. AETECH should improve this feature.

Useful packages. IntegrAda's extensive library of predefined Ada code packages is an excellent resource for developing Ada programs. The Ada package specifications are available in two forms—in the documentation and in on-line display screens from the Library Manager menu option.

The IntegrAda library includes more than 20 packages, ranging from low-level operations to music routines that generate sounds. Low-level operations are available for accessing memory, manipulating bits and bytes, accessing DOS and BIOS operations, and managing large programs and overlays.

Environment. IntegrAda is a new look for developing Ada software. This environment is screen-oriented; the function keys are bound to editing and system commands; pop-up menus and windows appear as color displays; and an optional mouse interface is operational. The editing function keys can be switched to map into either WordPerfect or WordStar definitions.

IntegrAda provides three different modes for editing Ada source code: Ada Sensitive, Design, and Text. Developers choose a mode through a windows that pops up when Shift-F1 is pressed. Ada Sensitive is the default editing mode. Upon entering this mode, the developer is prompted for the indentation level to be used for formatting the Ada structures. In this mode, IntegrAda behaves like a typical language-sensitive editor and creates Ada structures automatically.

The Design edit mode provides the same capabilities as Ada Sensitive mode plus a mechanism for including documentation and Program Design Language (PDL) within the Ada source code. In Design editing mode, documentation symbology is automatically included in the Ada structures. IntegrAda uses the documentation symbology of Software Systems Design Inc.'s Ada Design and Documentation Language (ADADL). The SSDI package extracts the symbols and their associated text from the Ada source code and reformats them to produce DOD-STD-2167 documentation.

IntegrAda's Text mode is used for updating or modifying an existing program. The features of both the Ada

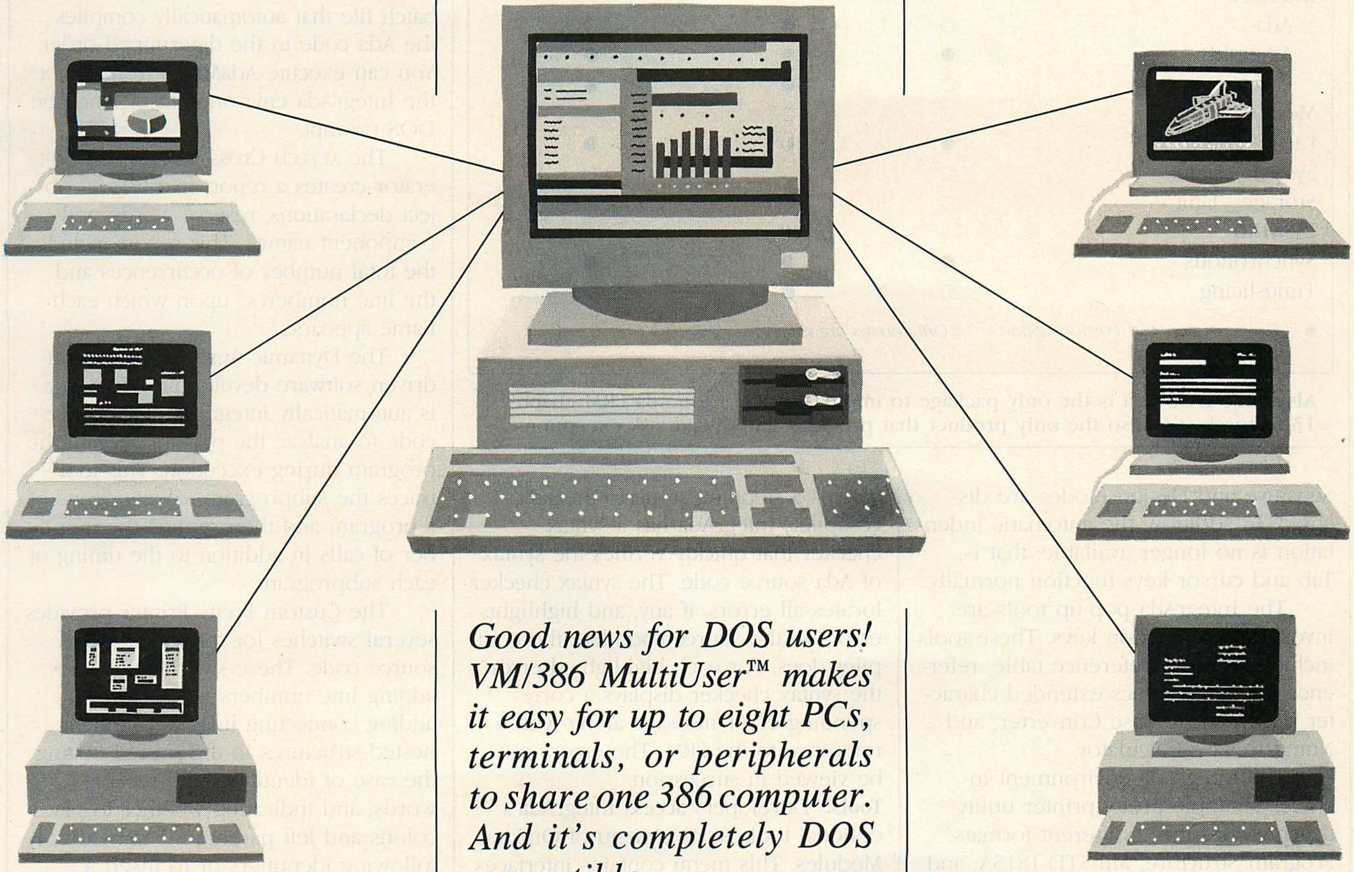
Now workgroup computing is simple. Thanks to VM/386 MultiUser, several terminals or PCs can share one 386 computer. Just add VM/386 MultiUser, a graphics adapter card and/or a multi-port card to your 386, and you'll have a multi-user system that is completely DOS compatible.

In fact, each application program sharing your 386 will have its *own copy* of DOS. So everyone will be able to continue using their favorite programs, without changing the way they work. As one user told us: "All you see is your application and DOS. You don't even know you're running on a multi-user system."

VM/386 MultiUser is based on VM/386,™ our multitasking program, which has won both the PC Magazine Technical Excellence award *and* Editor's Choice award. We've built that same solid product quality and functionality into VM/386 MultiUser.

Want more than one user to share your 386? VM/386 MultiUser is the easiest, most cost-effective way around the DOS single-user barrier. For more information, contact:
IGC, 4800 Great America Parkway, Santa Clara, CA 95054
Tel: 408-986-8373
Toll Free: 800-458-9108

Finaly: Multi-user DOS



Good news for DOS users! VM/386 MultiUser™ makes it easy for up to eight PCs, terminals, or peripherals to share one 386 computer. And it's completely DOS compatible.

IGC

TABLE 3: *Language Implementation*

	AETECH	ALSYS	MERIDIAN
PRODUCT	IntegrAda	286 DOS Ada	AdaVantage
CHAPTER 13			
Address clauses			
Address specification	○	●	●
Interrupt handling	○	●	○
Length clauses			
Size	●	●	○
Small	●	●	●
Storage_Size	●	●	○
Representation specifications			
Enumeration	●	●	○
Record	○	●	●
Unchecked_Conversion	●	●	●
Unchecked_Deallocation	●	●	●
PRAGMA			
InLine	●	●	○
Interface			
Ada	○	●	○
Assembly	●	●	●
C	○	●	●
Memory_Size	○	○	○
Pack	●	◐[a]	●
System_Name	○	○	○
Storage_Unit	○	○	○
TASKING			
Synchronous	●	●	●
Timeslicing	○	●	○

● = Yes ○ = No ◐ = Partial support *[a] Only arrays are supported.*

Alsys 286 DOS Ada is the only package to implement all of the Ada LRM chapter 13 features; it is also the only product that provides time-sliced task execution.

Sensitive and Design modes are disabled. In addition, the automatic indentation is no longer available; that is, Tab and cursor keys function normally.

The IntegrAda pop-up tools are invoked with function keys. These tools include an ASCII reference table, reference for the graphics extended character set, Numeric Base Converter, and Numeric Base Calculator.

The IntegrAda environment includes a simple pretty printer utility that provides three different formats: Program Structure, Mil-STD-1815A, and First Letter Capitalization.

IntegrAda also offers an attractive method for viewing Ada specifications and other files while working with Ada source code. Pressing Shift-F3 displays a pop-up window that prompts for the type of file to view. This includes Ada specifications that are withed (included) into the current Ada unit, Ada specifications that are resident in the IntegrAda library or the developer's Ada library, contents of the edit buffer, or any file on the system.

As a stepping stone to the Ada compiler, IntegrAda has a syntax checker that quickly verifies the syntax of Ada source code. The syntax checker locates all errors, if any, and highlights errors in the source code like the compiler does. For each highlighted error, the syntax checker displays a corresponding error message along with a reference to the LRM. The errors can be viewed in succession.

Tools. Developers access IntegrAda's optional tools from a menu of On-Line Modules. This menu contains interfaces to the training and reference session, assembler, Alsys Ada tool set, AdaSCOPE debugger, AdaMAKE utility, Cross Reference Generator, Dynamic Analyzer, and a customer Pretty Printer. These last four utilities are also referred to as the Software Development Toolset and are accessible from a separate menu.

From the On-Line Modules menu, you can invoke the Ada training and reference session on software engineering techniques and the Ada language (see photo 2). The assembler provides editing and interactive error correction for Intel assembly language and its interface with Ada through the IntegrAda environment. AdaSCOPE is a windows-oriented symbolic debugger that integrates Periscope's debugger with the IntegrAda environment.

The Alsys Ada interface provides access to the Alsys compiler and tools from within the IntegrAda environment via color menus and function keys. These pop-up menus make the Alsys system options and commands easily accessible and user friendly—a unique opportunity to use IntegrAda's PC-oriented user interface with the powerful Alsys Ada compiler and utilities.

AdaMAKE analyzes Ada source code and determines the associated legal compilation order of the Ada units. In addition, this tool generates a batch file that automatically compiles the Ada code in the determined order. You can execute AdaMAKE from either the IntegrAda environment or from the DOS prompt.

The AETECH Cross Reference Generator creates a report that lists all object declarations, reserve words, and component names. This report includes the total number of occurrences and the line number(s) upon which each name appears.

The Dynamic Analyzer is a menu-driven software development tool that is automatically integrated into source code to analyze the performance of the program during execution. This tool traces the subprogram call sequence of a program and then reports the number of calls in addition to the timing of each subprogram.

The Custom Pretty Printer provides several switches for formatting Ada source code. These switches include adding line numbers to the source, adding connecting lines to highlight nested structures in the source, setting the case of identifiers and reserve words, and indicating whether to place colons and left parenthesis immediately following identifiers or to insert a blank space between them.

Documentation. The IntegrAda documentation is detailed, but needs to be much better organized. A single binder houses the MIL-STD 1815A Ada LRM, the software description, and the IntegrAda system diskettes, making the package difficult to manage. The Ada LRM, at least, should have its own separate binder.

Overall, the IntegrAda system description is good. Detailed documentation is provided for installation, the

editor with all of the function-key definitions, the overall programming environment, the description of the predefined library Ada packages, and the Software Developers Toolset. Portions of remaining documentation, however, are very confusing. In particular, the description of the compiler and binder implementations and available options is significantly incomplete. More description is also needed on the implementation of Ada structures, especially the LRM's chapter 13 features. Developers will discover much of IntegrAda's power and flexibility only by actually using the system.

Performance. The PIWG results in table 4 are for IntegrAda with optimize features activated. IntegrAda does a fair job of executing the PIWG tests; however, it did have a few trouble spots. Two areas in particular are tasking and procedure calls. IntegrAda produced the worst execution times in these series of tests. Another potential for trouble involves dynamic allocation. For example, IntegrAda allocates only a single heap for a program, which can fill quickly when performing extensive dynamic allocations or from handling recursive subprograms. This heap overflow results in an Ada **storage_error** as listed for PIWG tests D3 and D4. This implementation of a single heap can be a potential problem when executing large programs. However, this can be prevented by implementing a good Ada design with strong modularity and using the IntegrAda package Big Array.

A fine Ada package. AETECH developed IntegrAda as a complete Ada development environment that provides the fundamentals of an APSE at a low cost and with a very friendly interface. The IntegrAda user interface, with its color displays, functions keys, mouse, and pop-up menus, is the product's predominate feature and its strength. In addition to the user interface, IntegrAda also provides a nice set of Ada software support tools.

Because IntegrAda is an inexpensive Ada environment with minimal hardware requirements, it is not surprising that the IntegrAda library manager, compiler, and binder are weak in a few areas. For example, the management of binary files and Ada libraries in general is nonexistent and left to the developer. This can be a disadvantage when developing and maintaining larger Ada programs. In addition, the compiler is premature in its implementation of some Ada features, such as tasking and the LRM's chapter 13 features. Therefore, the development of programs that need to use these Ada features is possible with IntegrAda but may be difficult. Both tasking and procedure calls are expensive in terms of time (see table 4). Also, some remaining items in chapter 13 have yet to be implemented. The use of a single heap can be a problem; however, this can be prevented by implementing a good Ada design with strong modularity.

IntegrAda is a good Ada programming environment for learning the language and for developing programs on the PC. It is a system that even a first-time Ada programmer can use immediately. After all, AETECH uses IntegrAda to develop IntegrAda. With its low cost, friendly interface, and Ada-environment support tools, IntegrAda is a pleasant yet substantial introduction into the world of Ada.

TABLE 4: ***PIWG Test Results***

	AETECH	ALSYS	MERIDIAN
PRODUCT	IntegrAda	286 DOS Ada	AdaVantage
COMPOSITE			
A91 (Dhrystone)	1,768.8	2,899.9	2,527.0
A93 (KWIPS)[a]	44	111	47
APPLICATION TRACKING (times in seconds)			
B1	Constraint error	Constraint error	4,535.97
B2[b]	442.21	254.0	804.06
B3[b]	470.50	298.5	804.05
B4	570.51	292.2	1,332.6
TASK CREATION			
C1	10,998.5	3,296.9	2,800.0
C2	11,501.5	3,343.8	2,850.0
C3	11,499.0	3,312.5	2,868.7
STORAGE ALLOCATION			
D1	112.5	161.9	1,218.7
D2	2,600.7	1,500.0	24,299.9
D3	Storage error	216.4	1,348.4
D4	Storage error	2,521.9	27,500.3
EXCEPTION HANDLING			
E1	70.3	151.4	98.8
E2	71.9	209.8	210.2
E3	65.5	217.2	87.9
E4	68.7	242.6	85.5
E5	Program error	865.6	328.1
STYLE			
F1	3.9	5.1	4.3
F2	3.9	5.0	5.3
INPUT/OUTPUT			
G1	2,514.6	1,757.8	1,511.7
G2	8,508.3	3,156.2	4,585.9
G3	56,005.9	600.6	44,999.7
G4	71,020.5	2,921.9	41,249.1
G5	859.1	556.6	869.1
G6	3,749.1	2,398.4	7,218.7
G7	0.0	0.0	0.0

ALSYS 286 DOS ADA

The Alsys 286 DOS Ada compiler is the best Ada environment on the PC market today, with capabilities comparable to mainframe and minicomputer Ada compilers. The system comprises a compiler, a linker, the development environment, and an optional tool set. The tool set includes AdaProbe, a symbolic debugger; AdaXref, a cross-refer-

	AETECH	ALSYS	MERIDIAN
CHAPTER 13 OPERATIONS			
H1	1,174.9	108.2	2,334.4
H2	1,162.4	450.0	4,837.5
H3	587.6	1,734.4	11,200.0
H4	587.6	468.0	1,321.9
H5	8.6	0.0	0.0
H6	71.9	38.7	0.0
ITERATION			
L1	10.0	4.3	4.5
L2	17.0	5.3	5.4
L3	17.0	5.7	5.4
L4	6.3	5.6	6.1
L5	8.8	5.5	5.2
PROCEDURE CALL AND RETURN			
P1	59.4	0.0	8.6
P2	103.1	7.6	100.4
P3	62.5	9.1	12.7
P4	59.4	0.0	12.7
P5	67.2	10.4	16.4
P6	76.6	10.7	20.5
P7	57.8	11.5	25.8
P10	78.1	2:34.0	30.1
P11	92.2	37.5	44.9
P12	103.1	48.8	57.0
P13	121.9	90.2	98.8
TASK ENTRY AND RETURN			
T1	4,000.9	691.4	1,125.0
T2	4,099.7	678.1	1,115.6
T3	3,999.6	685.9	1,192.2
T4	4,675.3	1,082.8	1,407.8
T5	3,950.2	672.5	1,265.0
T6	7,679.9	2,430.0	2,557.5
T8	9,050.3	2,421.9	3,178.1

All results are in microseconds, unless otherwise noted.

The tests were run on an 8-MHz IBM PC/AT Model 339 with a 287, 30MB hard disk and 4MB of RAM.

[a] *Thousand Whetstone iterations per second.*

[b] *Pragma Suppress was used.*

Programs compiled using the powerful Alsys package outperforms those compiled in the other two Ada environments in nearly every category of the PIWG tests.

ence generator; AdaReformat, a pretty printer; and AdaMake, a compilation dependency reporter.

Developers can purchase the software in two kits. The basic software kit consists of the AdaWorld environment, the compiler, and the linker for $3,595; annual maintenance (mandatory for the first year) is $360. If the optional tool set is purchased together with the basic software kit, the total price is $4,395, plus the required maintenance. Purchased separately, the tool set is $1,190.

The Alsys system requires an IBM PC/AT or compatible running DOS 3.0 or later and the DOS linker 2.3 or later. Alsys software consumes about 7MB on the hard disk; this includes a demo program and the Ada Sampler, an excellent tutorial on the Ada language and the Alsys compiler. The system also requires a minimum of 4MB of extended memory; to this end, Alsys includes an extended memory board with the package (thus accounting for a portion of the steep price of the basic kit). The system requires an 80287 math coprocessor if the Ada source code accesses the Float_IO or Fixed_IO packages of Text_IO, or uses floating-point or Universal Real type operations.

Three programs included in the AdaWorld environment are extended-mode programs: the Ada compiler, AdaProbe, and AdaXref. These programs must be loaded onto and executed from a virtual disk, which you create using the extended memory board during installation.

Compiler. The Alsys compiler offers a wealth of options and features (see table 2). Certain options control the level at which source code is analyzed and code is generated; that is, you can direct the compiler to behave like a syntax and semantics checker as well as a controller of generics and tasks.

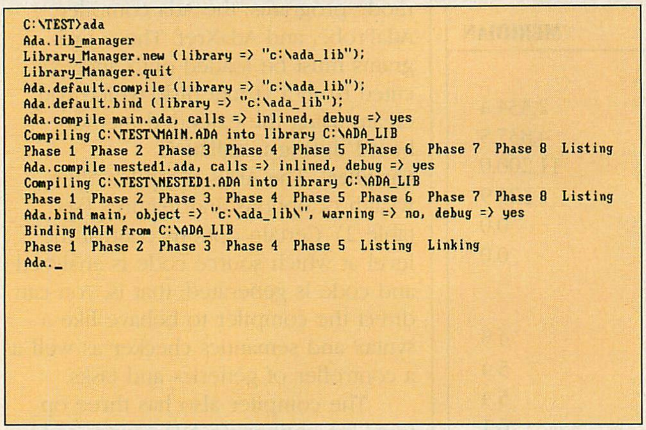
The compiler also has three options for optimizing Ada source code: calls, reduction, and expressions. The calls option lets the compiler use InLine on programs for efficiency even if the program was not explicitly specified as InLine in the source code. Reduction removes dead code and eliminates many runtime checks. Expressions performs low-level optimization by eliminating subexpressions and adding register optimization.

As table 3 shows, Alsys is the only compiler reviewed that implements the majority of the Chapter 13 features. This compiler is comparable to mainframe and minicomputer Ada compilers, albeit with a few restrictions. It defines the pragma Interface for assembly language, C, and Ada. Other pragmas implemented by the compiler are Priority, Suppress, and InLine; however, it implements pragma Pack only for arrays, not for records.

Alsys implements Chapter 13 address clauses and interrupt entries—but not entirely according to the LRM. The **for . . . use at . . .** statement, which is used to assign a data object to a known hardware address, is not implemented by Alsys. Instead, the developer must instantiate and use the generic functions Reference and Fetch_From_Address along with the generic procedure Assign_To_Address, all of which are located in the System package.

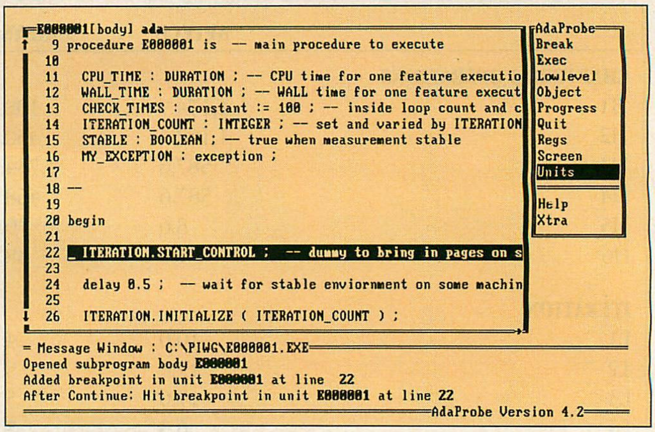
AdaWorld handles interrupts in two ways—either as defined by the LRM, or through the environment's Interrupt_Manager package. Using the Alsys mechanisms for address clauses and interrupt handling when programming decreases source-code portability. Ada code that uses this implementation is not completely compatible between the Alsys environment and other Ada environments; thus, such sections of Ada code should be isolated as much as possible.

PHOTO 3: *AdaWorld Compile and Bind*



Entering ada at the DOS prompt starts the Alsys AdaWorld environment; subsequent commands to begin compile and bind operations are entered at the Ada prompt.

PHOTO 4: *AdaProbe Main Menu*



Alsys AdaProbe is a windows-oriented symbolic debugger that supports multiple breakpoints, command execution, object manipulation, and viewing of source code using menus.

In AdaWorld, the Bind command performs linking. The options listed in table 2 control its implementation and different parts of the runtime system. Similar to compile options, the linker executes at various levels that may or may not produce an executable image. In addition to these options, others are available to set stack and heap sizes and to control the detail that appears in the binder-generated listings.

You can use Bind to specify the execution mode for the generated executable image—real, protected, or extended. When generating an extended-mode program, Bind produces both an .EXE and an .EXT file. Because Alsys does not provide an extended memory loader, the .EXT file must be copied to the virtual disk before the program can be executed.

Library management. Alsys provides a more structured and controlled mechanism for managing multiple library environments than library systems found on most mainframes and minicomputers. AdaWorld implements three levels of library control—family, library, and unit—which Alsys calls the *manager tools*.

The family manager maintains groups of related libraries, with commands to create, erase, rename, mend, and unlock families. Mend recreates a family after the family has been corrupted; that is, after a system crash. The library manager consists of all the operations necessary for creating and maintaining individual libraries within a given family.

The unit manager operates on Ada *units*, the contents of a single specified library within a given family. This includes creating links to other libraries, changing the current library to a new name, checking the unit for linking (all other units that are referenced exist and have not been recompiled), as well as viewing information on a given unit and its library.

Useful packages. Alsys provides three Ada packages to assist in the development of Ada source code. Two of the packages supply an interface to DOS operations. The package DOS contains the types and subprograms for accessing DOS interrupt services along with the majority of DOS 3.1 operations. The package DOSE provides the interface necessary for a program to control its own error handling. In addition to these packages, Alsys provides the package Unsigned. This package provides types that define unsigned bytes and words and operations related to these types.

AdaWorld. Entering ada at the DOS prompt places you in the AdaWorld environment where you have access to AdaWorld commands as well as general commands (see photo 3). AdaWorld is completely line-oriented except for AdaProbe, the symbolic debugger. AdaWorld commands include not only compile and bind, but commands that provide access to the majority of the Developer's Toolset and entry into the manager tools.

The AdaWorld commands use the same syntax as Ada procedure calls: the command name is listed as a procedure name would be, followed by the list of parameters enclosed within parentheses, and finished with a semicolon. These parameters represent the available options for each of the AdaWorld commands. Modeling the Ada syntax, parameter values can be specified by name and positional notation. Variations on the command line syntax are possible, allowing for command abbreviations and for the commands to be invoked from the AdaWorld level as well as from DOS.

Tool set. Of the tools in the Developer's Toolset—AdaProbe, AdaXref, AdaReformat, and AdaMake—all but AdaMake are invoked from AdaWorld. AdaMake is invoked from DOS. Interestingly, Alsys does not provide a source-code editor, not even a language-sensitive editor.

AdaProbe, a complete symbolic debugger, surpasses many of its mainframe/mini counterparts. AdaProbe operations include management of Ada source code that is being debugged or viewed, control of multiple breakpoints, execution commands, object manipulation, screen-window control, function-key assignments, and viewing capabilities (see photo 4). The View command lets you determine how a program's source code is displayed within a viewing window.

AdaXref produces a list of cross references for each compilation unit submitted to it. AdaReformat provides a pretty-printer capability through which developers can impose style control in the command arguments.

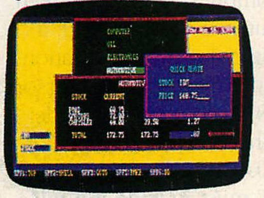
AdaMake determines the compilation order of a given list of Ada source files. As its output, AdaMake generates an AdaWorld command file containing the commands to compile the list of Ada units according to the determined compilation order as well as the command to bind the entire program.

Documentation. The documentation for the Alsys Ada environment is thorough, concise, and well organized. Examples

How to match the best front end with the best back end.

You've invested in the best hardware, operating system and database products. You have a staff of programmers ready to go. But to build great looking applications with the sophisticated features today's users demand, you need a powerful front end development tool—JAM.™

JAM, the most advanced user interface management system on the market, does it all—from prototyping to implementation. And, because it works with any database or file manager, you get the best front end *and* the best back end.



Create colorful screens and nested windows easily.

JAM is hardware independent, so it isn't limited to one computer, database or operating system. In fact, JAM runs on everything from PC's to super-minis, works under 7 operating systems and provides access to a host of database products. Using JAM you can create a consistent user interface across multiple systems and hardware platforms.

JAM works under the following operating systems:

- UNIX®
- MS-DOS®
- VMS®
- XENIX®
- AOS/VS™
- RMX™
- VOS™

JAM makes it easier than ever to design and revise complex applications. Using features like context-sensitive help, procedural command language (JPL), shifting and scrolling fields, extensive data validations, on-line testing, and a variety of visual attributes, you'll be amazed how quickly your applications spring to life.

JAM is fast, as well as flexible. Development time is reduced significantly thanks to JAM's powerful screen drawing utilities and comprehensive library of subroutines. You can easily create and link together screens, windows, and menus to develop an application shell. Then simply attach the processing routines, and your application is complete.

Plus, if your back end is an SQL-compatible relational database like Oracle,® SQLbase,® Informix® or Britton Lee,™ you'll really appreciate JAM/DB*i*, JAM's optional database interface. With JAM/DB*i*, you can develop entire applications using only industry-standard SQL statements and JAM's authoring tools.

Use SQL to retrieve and display data.

So if you're programming in a 3GL like C or FORTRAN, follow the lead of the many Fortune 1000 companies who have already discovered JAM.

JAM from JYACC. It gives you the best at both ends.

Call for more information about JAM and our demo diskette. **800-458-3313**

JYACC, Inc.
116 John Street
New York, NY 10038
212-267-7722 FAX No. 212-608-6753

JYACC

JAM

JYACC Application Manager. *The Composer for Sophisticated Applications.*

CIRCLE NO. 128 ON READER SERVICE CARD

are provided, as is a fine tutorial. It provides a thorough overview of the Ada programming language, the AdaWorld environment and its capabilities, and examples of Ada design and coding styles. Alsys even provides the Ada LRM as part of its documentation.

Performance. As shown in table 4, programs compiled using the Alsys compiler out-perform the others in almost every category of the PIWG tests. Alsys is not so fast in the Exception Handling tests, however; in these tests, IntegrAda was approximately three times faster. Nonetheless, when developing a program targeted for the PC with extensive timing requirements, the Alsys compiler is the best choice.

A complete Ada package. In many ways, Alsys provides more capabilities than a mainframe Ada system. If the price seems high, this system is for the serious PC Ada programmer who needs a complete implementation of Ada.

AdaWorld is designed as an extension of the Ada language, where all commands can be invoked using Ada syntax rules. Commands also can be invoked using a modified version of Ada syntax rules. This interface is not as user-friendly as IntegrAda's, but it gets the job done.

Alsys 286 DOS Ada is very powerful and is recommended for any developers who can justify its price and system requirements. An application is only as good as its compiler: large, complex Ada applications need the capabilities that Alsys provides.

MERIDIAN ADAVANTAGE

Developers can access the versatile AdaVantage environment from DOS, similar to the access of mainframe Ada systems, or through the completely contained environment called Ada Developer's Interface (ADI). Also similar to a mainframe implementation, you issue library-management, compile, and link commands independently of each other in succession at the DOS prompt. A programmer familiar with DEC's Ada Compilation System will have no difficulty with AdaVantage. As an integrated environment, AdaVantage provides additional support tools.

The AdaVantage PC Developer Kit consists of the compiler, the ADI, linker, library manager, symbolic debugger, and the predefined packages DOS and Utilities, and costs $1,095. The AdaVantage PC Professional Developer Kit includes these items plus a program optimizer and software required to generate and run programs in extended, as well as real mode. The professional kit goes for $1,780.

System requirements are an 8086-compatible system with a 2MB hard disk, 640KB RAM, and running DOS 2.1 or later. The compiler supports a math coprocessor, but it is not required; a software floating-point implementation is available if no hardware coprocessor is present. CONFIG.SYS must include the command that sets the number of open files to 20. The path command in AUTOEXEC.BAT must include the full path names to the AdaVantage compiler and linker subdirectories.

Compiler. The AdaVantage compiler uses the standard internal representation for data along with several optional definitions. The compiler handles generics delicately. For each instantiation of a generic, the corresponding code is fully expanded. This speeds up program execution, but the executable image grows in size. Also, the specification of a generic, along with its body and the subunits, must all reside in the same file.

Tasking is not implemented with true time-slicing preemptiveness, but

with scheduled switches: tasks are switched at tasking constructs, such as activation, termination, rendezvous, and delay statements. Therefore, one of these conditions must exist in each task or the task is never preempted. If a task has no need for any of the above mentioned constructs, you are recommended to place a **delay 0.0**; statement in the task, thus forcing the switch.

AdaVantage does not deliver a complete implementation of the LRM's chapter 13. Pragmas not supported include InLine, Controlled, Memory_Size, Optimize, Storage_Unit, and System_Name. Pragma Interface is provided for C and assembly language. In addition, pragma Pack is implemented for both array and record types. It does not support representation specifications for interrupt entries in tasks, but it does support address clauses as 32 bits. Representation specifications for record types are implemented to the bit level; however, they are not for enumeration types.

The AdaVantage compiler can compile Ada source code either interactively or in batch mode. In the interactive mode, Entering the command Ada at the DOS prompt activates the compiler. See table 2 for the list of compiler options. Associated with the options is a symbolic debugger, source-code optimizer, and the capability of generating extended-mode programs.

By default, the AdaVantage compiler places the same restrictions on source code as most applications running on an 8086 system under DOS. A single compilation unit cannot exceed 64KB of memory. In addition, a program's global data and a single data object cannot exceed that limit. The size of the runtime stack is variable, however, and can be defined at link time. The stack space has a default of 20KB and a limit of 64KB. This DOS limitation is overcome by using the extended-mode option with the **bamp** (an acronym for build Ada main program) link command.

Programs operating in extended mode have access to as much as 16MB of extended memory at one time, and programs have a separate address space from the operating-system address space. These extended-mode programs are run with the command **ramp**. You issue **ramp** at the DOS level, followed by the name of the program's main procedure. This extended-mode feature is a great advantage when developing large programs. Extended-mode programs cannot be developed under the ADI environment.

Library management. AdaVantage provides a universal library-management system that is implemented with one file that maintains a database of compilation units and an auxiliary subdirectory containing the associated binary files that result from compilations and linking. This feature allows a subdirectory to contain only source and executable files, remaining free of unnecessary object and description files. In addition, libraries can be linked together to form hierarchies: developers can maintain baseline versions of Ada source code while continuing development in other areas.

Predefined packages. AdaVantage's excellent predefined Ada packages interface with the low-level PC operations. The DOS Environment packages access a majority of the DOS and BIOS commands as well as screen-management operations. These interface packages are included in both AdaVantage software kits and provide operations to control disk devices, manage memory, perform byte or word transfers, control programs, and handle graphic capabilities. Utility packages are included in the software kits as well. The documentation contains specifications for each package, along with a detailed description of all procedures and functions.

Ada Developer Interface. The ADI integrates the compiler, linker, debugger, optimizer, Ada Template Editor (AdaTE), and pretty printer into a single environment. Although integrated, this development environment is not without its problems.

ADI requires 450KB of free memory on the hard disk in addition to the previously specified requirements. In addition, AdaVantage provides a list of recommended requirements that guarantee the necessary resources for all the tools included in the ADI. The system must have at least 600KB on the hard disk and 640KB of RAM and be running DOS 3.1 or later.

The ADI environment displays all the compilation units of the program with the AdaVantage operations (edit, format, compile, and link) in a matrix structure (see photo 5). The compilation units are listed as the rows of the matrix and AdaVantage operations are the columns. The matrix rows have a special order: in relation to the main procedure, the root—the library units that are withed in—are listed below the main procedure, whereas nested Ada units are listed above it.

This grid feature provides a visual structure of the Ada program in multiple levels. To activate an AdaVantage operation on a compilation unit, press Enter at the appropriate grid location (the intersection of the compilation unit's row and the operation's column). In addition to providing an interface to commands, this display shows the development status of each unit. With this type of display, it is easy to see, for example, which units need formatting with the pretty printer as well as which must be compiled.

Although the ADI system provides useful tools, its presentation of the environment is not fully mature. Each AdaVantage operation uses a unique icon, but the documentation does not describe the form of the icons. In addition, the meaning of each icon is not placed on the icon form, but on the display attributes of the icon—is it blinking, highlighted, normal?

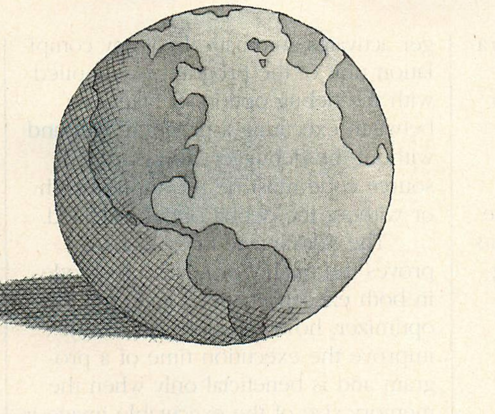
The help facility is too simple considering the complexity of the ADI system that it describes. On-line help offers only basic definitions for keystrokes. It should provide information on ADI concepts and how they relate to each other.

AdaTE provides fundamental language-sensitive editor commands. Developers can enter templates of Ada constructs into a file with only a few keystrokes, thus encouraging correct syntax. However, only a subset of Ada structures are provided: no templates for procedure and function specifications are available, although templates for the Ada subprogram bodies are.

Several other problems arise in software development under ADI. One is that it appears that the full range of compiler and linker options is not available through ADI. When compiling an Ada unit, ADI lists only a few options of which only one can be activated for the current compilation. When linking a program, only the optimization option is available; therefore, you cannot generate and execute an extended-mode program. Such a program can only be linked and executed from DOS. Commands to access multiple compiler or linker options also must be issued from DOS. According to Meridian the user can set the ADI compiler and linker options table; however, this is not described in the current documentation.

Another problem involves recompilation. If you change a parent unit, and then recompile it, the dependent units cannot simply be recompiled from ADI. Such dependent units must be edited before a recompilation can occur even if the edit is unnecessary, for instance, the insertion of a space or

CIRCLE NO. 110 ON READER SERVICE CARD



The UNIX Software Operation was created to serve one particularly exclusive market.

As we celebrate 20 years of development, the UNIX® system has become recognized as the standard in operating systems around the world. This is confirmed by a customer list that includes every major system vendor committed to open systems, and even some who are not.

The unique capacity of the UNIX system to satisfy the needs of a range of users has made it a catalyst of the open systems' movement.

Market acceptance of the UNIX system, which was first licensed by AT&T 13 years ago, has been overwhelming. As a result, AT&T created the UNIX Software Operation as a separate business unit to serve all users of UNIX System V-based products.

This is the latest milestone in the UNIX System V heritage of responding to the marketplace and customers. Key product enhancements are also evidence: Releases 3.0, 3.1, 3.2 delivered networking, internationalization, XENIX®/386, and security features.

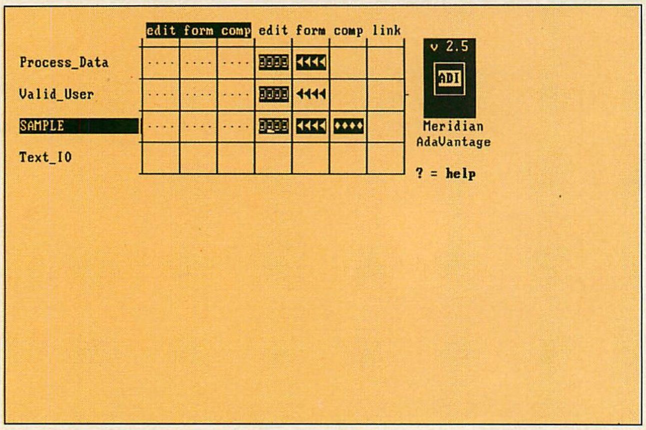
The UNIX system's inherent capacity for upward migration assures that ongoing technology of UNIX System V Release 4.0 will be available to all our customers—current and future.

With every enhancement, the UNIX Software Operation will continue to keep UNIX System V portable, compatible, interoperable, scalable, and standard compliant. All of which will be achieved only through accountability to each and every customer who needs true open systems functionality.

To find out more about UNIX System V and the UNIX Software Operation, call 1 800 828-UNIX.

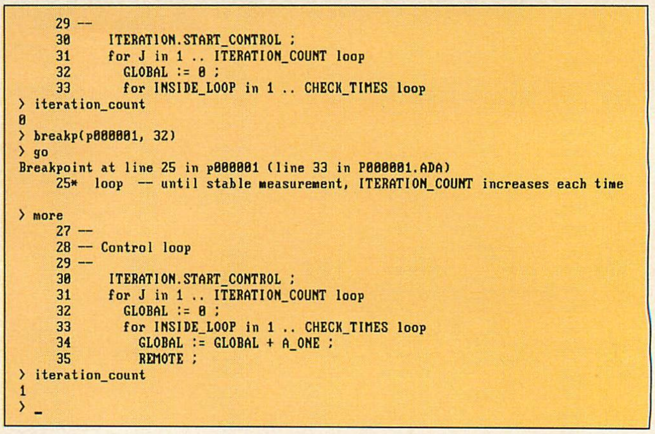
AT&T
The right choice.

PHOTO 5: *AdaVantage ADI Grid*



The developer can start an AdaVantage operation on an Ada compilation unit by pressing Enter at the intersection of the compilation unit's row and the operation's column.

PHOTO 6: *AdaVantage Debugger*



```
     29 --
     30      ITERATION.START_CONTROL ;
     31      for J in 1 .. ITERATION_COUNT loop
     32        GLOBAL := 0 ;
     33        for INSIDE_LOOP in 1 .. CHECK_TIMES loop
> iteration_count
0
> breakp(p000001, 32)
> go
Breakpoint at line 25 in p000001 (line 33 in P000001.ADA)
     25*  loop  -- until stable measurement, ITERATION_COUNT increases each time

> more
     27 --
     28 -- Control loop
     29 --
     30      ITERATION.START_CONTROL ;
     31      for J in 1 .. ITERATION_COUNT loop
     32        GLOBAL := 0 ;
     33        for INSIDE_LOOP in 1 .. CHECK_TIMES loop
     34          GLOBAL := GLOBAL + A_ONE ;
     35          REMOTE ;
> iteration_count
1
> _
```

The AdaVantage debugger activates if an Ada program has been compiled with the debug option; here, it is used to examine a variable, set a breakpoint, and view source code.

line. Finally, library-management operations are not accessible from ADI. All development libraries must be set up and constructed before entering ADI.

Tools. The symbolic debugger is a powerful addition to the AdaVantage tool set and is included in both of the software kits. Similar in capability to its DEC counterpart, the Meridian debugger executes in a split-screen mode that lets you view the source code while the program executes. Operations include setting and clearing breakpoints, examining variables, assigning values to variables, monitoring program execution, and watching flagged variables (see photo 6).

One annoying aspect of the debugger is that rather than being a separate tool invoked on command, the debugger activates automatically if any compilation unit of the program is compiled with the debug option. To alternate between executing a program with and without the debugger, all associated source code must be recompiled with or without the debug option selected.

The AdaVantage optimizer improves the quality of Ada source code in both execution speed and size. This optimizer, however, does not always improve the execution time of a program and is beneficial only when the memory size of the executable image is critical to a program. In all test cases, the size of a program's executable image was reduced by about 40 percent when compiled and linked with the optimize option; however, using the optimizer does not reduce a program's execution time. In many cases, the execution time of an optimized program actually increases. Another drawback to accessing the optimizer is an increase in the time necessary to link a program. A link with the optimize option runs approximately eight (or more) times longer than linking without the optimize option.

Documentation. The AdaVantage documentation is a mix of good detail and good intention. The first strike is that all of the material resides in one, extremely awkward binder, when every main topic could use its own binder. On the other hand, the installation instruction are explicit and include a section on troubleshooting.

Descriptions of the AdaVantage commands and options are detailed,

WHETHER REPORT.

Whether you're a software developer writing new applications for the IBM or Mac, or a PC user securing proprietary data files, software and data protection has never had a brighter silver lining. For a number of very good reasons.

Beginning with the 'whether-expert' Rainbow Technologies. And ending with its Software Sentinel family of hardware keys. Starring five models that fit virtually any software program or data file you need to protect.

There's the best-selling SentinelPro for the IBM PC/XT/AT, PS/2 and compatibles, and even the Atari ST. Known worldwide for its virtually unbreakable security. And its ASIC technology. And its invisible operation. A close relation, the Sentinel-C stands at-the-ready for custom configurations and multiple software packages.

In the Apple market, security-minded Mac software developers turn to Eve. For completely transparent operation and world-class security of the protected software. Just by plugging Eve into the Mac ADB connector.

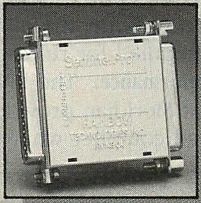
PC users wanting a low cost, user-friendly solution to the problem of securing sensitive data can call on the DataSentry. Using a proprietary Rainbow algorithm or DES, the DataSentry encrypts data files on individual PCs, protects modem transmissions and secures data on local area networks.

Rainbow's latest protection strategy is the SentinelShell–that lets users place a 'shell' around existing, off-the-shelf programs. Because access can be limited to those issued a key, libraries, universities and corporations can very simply guard their software investments.

Whatever your whether, Rainbow Technologies has the software and data protection products that make the difference. For more information, call 714-261-0228 in the U.S., or contact Rainbow Technologies Ltd. in the United Kingdom for the distributor nearest you. Whethercasters are standing by.

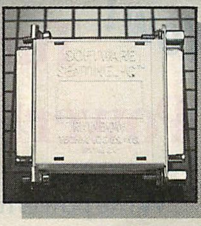
SentinelPro™

• Runs under DOS, OS/2 and Xenix • Algorithm technique (Never a fixed response) • External parallel port installation • Minimal implementation effort • Higher level language interfaces included • 100 times faster than fixed-response devices (1 ms) • ASIC design for reliability



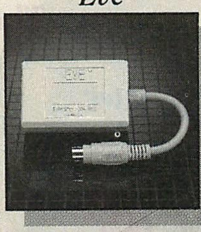
Sentinel-C™

• Protects multiple packages with one device • 126 bytes of non-volatile memory programmed before shipment of the software • Rainbow supplies a unique adapter for programming the unit • Higher level language interfaces included • Runs under DOS, OS/2 and Xenix • External parallel port installation



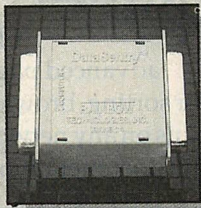
Eve™

• For the Macintosh SE and II • Complies with Apple Desktop Bus Interface requirements • Rainbow-assigned developer passwords to prevent tampering by other developers or sophisticated "hackers" • 7 locks per key, usable individually or in combination, on one or up to seven applications



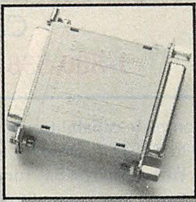
DataSentry™

• Completely user-installable • Pocket-sized external device • Menu-driven, user-friendly interface • Single- or multi-user security system • Audit trail, log-on identifiers and automatic encryption/decryption of entire directories • Secures data transmitted by modems • Prevents recovery of data by utility programs



SentinelShell™

• Runs under DOS on IBM PCs and compatibles • Protects without requiring access to the source code • Completely transparent to the end user • User-friendly software • Pocket-size key attaches quickly to any standard PC parallel port • ASIC design for reliability



RAINBOW TECHNOLOGIES

18011-A Mitchell South, Irvine, CA 92714 • (714) 261-0228 • TELEX: 386078 • FAX: (714) 261-0260

Rainbow Technologies, Ltd., Shirley Lodge, 470 London Rd., Slough, Berkshire, SL3 8QY, U.K., Tel: 0753-41512, Fax: 0753-43610

CIRCLE NO. 157 ON READER SERVICE CARD

but other sections are sparse. The ADI documentation, in particular, is premature, and the on-line assistance is of no help. The document does not fully prepare you for the ADI environment and should be expanded. The tutorial is also incomplete, but hope is on the horizon. Meridian is currently revamping the entire AdaVantage documentation package; the new documentation is scheduled for release later this year.

Performance. The PIWG results show that Meridian provides a middle-of-the-road compiler where the execution times are neither the fastest nor the slowest overall. There are a few areas where Meridian performs poorly. This includes the Chapter 13 and application tracking tests. Based on the PIWG results, the AdaVantage system provides an adequate Ada compiler.

Incomplete implementation. Meridian's AdaVantage system consists of a premature Ada compiler and linker (even though extended-mode programming is possible) with an incomplete development environment. Programs requiring the use of generics, tasking, and low-level language features have to work within constraints set by AdaVantage.

Disadvantages of the ADI environment include not having AdaVantage capabilities available from within the development environment. A programmer cannot access a complete language-sensitive editor, many compiler and linker commands, or library-management operations. In addition, ADI has several idiosyncracies that inhibit easy and efficient generation of Ada source code.

One nice feature of AdaVantage is that you can invoke Ada commands easily from DOS. These commands have access to the full range of compiler and linker options.

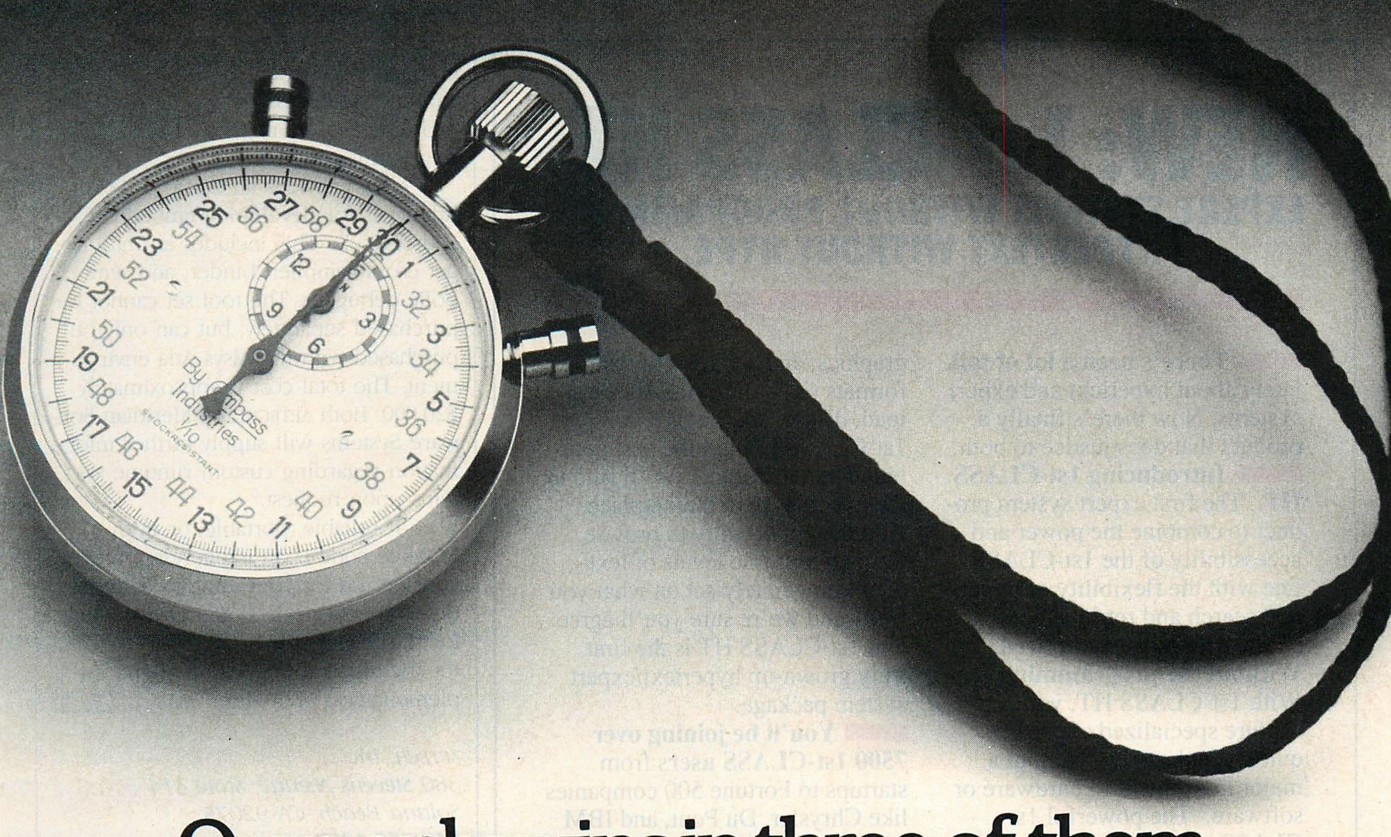
This Ada system is sufficient for general applications that do not heavily rely on nested generics, tasking, or LRM chapter 13 features. Because AdaVantage provides the management of multiple libraries and extended-mode programming, small as well as large programs can use structured methods. Despite the ADI development environment's being incomplete, you can generate Ada source code within this simple APSE system.

FACE VALUE

Current Ada environments for the PC implement a diverse set of capabilities for a range of prices. The two areas of difference among these environments are user interface and compiler maturity. The IntegrAda interface is a powerful and friendly, and allows a user to move easily from one operation to the next. The Alsys compiler, however, is the most mature. It implements the majority of the Ada LRM to a level comparable with any mainframe Ada compiler. The Meridian environment is an acceptable Ada development system, but it does not compare to the power and ease of the IntegrAda development environment.

For large programs that use many Ada features, such as generics, tasking, and low-level operations, the Alsys environment is the appropriate Ada system. You usually get what you pay for, and Alsys provides the best Ada compiler for the PC. If you do not have such programming requirements and are flexible about the capabilities of your Ada compiler, then IntegrAda is well-defined to meet your needs. If parallel development is a must, then a library-management capability may be the driving force behind a decision; however, the user interface must always be a consideration, as well. The three described here offer a range of

THERE ARE FOUR WAYS TO MEASURE THE SPEED OF A LAN.



Ours only wins in three of them.

1. How fast does it install.

We have no competition in this category. LANLink 5X installs in about fifteen minutes, and it doesn't take a technician to do it. Since LANLink 5X uses standard parallel or RS-232 serial ports, installing a network means little more than connecting the cable and loading the software.

With hardware LANs, installation can easily take two days–one to set it up and one to tweak it. And it also takes someone who really knows what he's doing. That is, someone expensive.

2. How fast does it transmit.

Okay, this is the category we don't win; the hardware LANs are generally a little quicker. At least, they are under optimal conditions, which is how they rate themselves.

But LANLink 5X is pretty quick, too. At half a megabit per second, it's way out ahead of any other software LAN, and right at the heels of the hardware types. Which, of course, are far more expensive.

3. How fast does it maintain.

The real cost of a network is not so much the initial price as it is the continuing outlay for maintenance–adapting it to changing needs. That's something LANLink 5X does practically on its own.

Running under PC-MOS/386™ or PC-DOS, it turns your server PC into a multi-tasking controller, driving a truly expandable LAN that is easily and quickly upgradable.

A hardware LAN, on the other hand, becomes obsolete as new technology is introduced. And, to keep the network up and running as applications change, you need the attentions of a technician, on a continuing basis. A very well-paid technician.

4. How fast can you pay for it.

Now we've arrived at the bottom line, where LANLink 5X is toughest to beat. You can install a five-user LANLink network for about the same cost as the LAN board in a board-driven network. On top of that, factor in what you save on installation and maintenance time, and the difference is pretty dramatic.

LANLink 5X is available immediately, and it comes with a money-back guarantee. Its price of $595 includes a server and a satellite module plus the network operating system. Additional satellites are available for $125.

For complete details on the fastest software-driven network available, call 800-451-LINK.

LANLink 5X. Because three out of four ain't bad.

LANLINK 5X

THE SOFTWARE LINK

3577 Parkway Lane, Norcross, GA 30092 (404) 448-5465 FAX (404) 263-6474

CIRCLE NO. 196 ON READER SERVICE CARD

interfaces, including a PC-oriented, menu-driven system; a mainframe-style, line-oriented system; and one with a grid- or mainframe-style approach.

Another factor for determining which Ada development system is best, involves the issue of runtime royalties. All Ada systems contain an Ada Run Time System (RTS). The RTS is automatically linked in with an Ada program and it is used to isolate the program from the operating system and the hardware dependencies. When AETECH's IntegrAda development system is used to create such a program, no runtime royalties are required to be paid to AETECH.

Alsys, on the other hand, does require runtime royalties. Included with the purchase of the AdaWorld environment is 10 licenses—that is, 10 copies of the Alsys Ada RTS are free. A royalty must be paid to Alsys, however, for any unit over 10.

Meridian Software Systems does not require any runtime royalties for programs using the default Real mode. A royalty must be paid, however, if the program accesses the extended-mode capabilities of AdaVantage. This royalty is not paid to Meridian, but is paid to AI Architects—the software company from which Meridian obtained its extended-mode capabilities. All licenses and royalties are negotiated per program; therefore, there are no set fees.

The Ada runtime system is also an issue when a user needs to develop ROMable, embedded code. Such code does not require DOS or any other comparable operating system to execute. This type of program resides in a system's ROM and starts executing when power is supplied to the system. In order to develop a ROMable or embedded program, a customized Ada runtime system is needed. Each vendor provides this capability as a separate development domain.

Alsys provides an entire series of Ada tools for developing embedded source code. This includes an Intel target cross-compiler, binder, and symbolic debugger. The tool set cannot be purchased separately, but can only be purchased with the Alsys Ada environment. The total cost is approximately \$20,000. Both AETECH and Meridian Software Systems will supply further information regarding custom runtime systems upon request.

If reliable, portable, or even ROMble code is an issue, Ada is worth considering for your next PC software development project. Ada environments for the PC provide a powerful platform for the efficient development and implementation of applications.

AETECH, Inc.
380 Stevens Avenue, Suite 314
Solana Beach, CA 92075
619/755-1277
IntegrAda 4.10: \$795
CIRCLE 340 ON READER SERVICE CARD

Alsys, Inc.
1432 Main Street
Waltham, MA 02154
617/890-0030
286 Ada DOS 4.2: \$3,595
CIRCLE 341 ON READER SERVICE CARD

Meridian Software Systems, Inc.
23141 Verdugo Drive, Suite 105
Laguna Hills, CA 92653
714/380-9800
AdaVantage PC Professional Developer Kit 2.2E: \$1,780
CIRCLE 342 ON READER SERVICE CARD

Megan Dortenzo is a software engineer at Westinghouse Electric Corporation in Baltimore, Maryland.

PRICED TO SAVE, SHIPPED FAST!!!

FRONTRUNNER *(a new Ashton Tate product created by Apex Software)*

FrontRunner generates memory-resident **pop-up** applications using the dBASE III Plus or dBASE IV programming language. Once your memory-resident program is created, **pop-up** your program while using Lotus 1-2-3, any dBASE program, Clipper, Basic, any word processor, DOS or any program written in any language. Pop-In and Pop-Out of any software package instantly. All data files and indexes created are dBASE compatible. FrontRunner applications can be compiled into binary files for protected distribution and unparalleled speed. The user selects a hot-key to call up an application. Use the unique POWERKEY feature to define additional hot-keys within the application. A powerful paste command allows the user to extract data from a FrontRunner application into a word processor, spreadsheet or other application. Use FrontRunner for **pop-up** help screens, account listings, phone directories, schedules, random notes, printing mailing labels.... anything imaginable.

FrontRunner....List: **$295**, Ours: **$195**
(new low price!)

GREENLEAF LIBRARIES

Functions

C source, assembler source, and binary libraries of 225 functions for many compilers. Emphasizes tight functional groupings to minimize loading code which your application may never use. Manual's 250 pages help select functions, as do demos, bulletin board.

Communications

Communicate from within your own C programs! Over 120 functions and demo programs in C and assembler source to set up interrupt-driven asynch communications for up to 16 channels. Up to 9600 baud, ASCII or binary, any parity or word length, 8250 UARTs, Xon/Xoff and Xmodem, WideTrack receive. Goodbye separate communications software. Specify compiler.

Data Windows

Windows, menus and data entry do work together....when you utilize Greenleaf's screen architect. This smooth screen designer offers device independence, logical windows, table driven data entry and economical pricing. Source code is also available.

	List	Ours
Communications	**$185**	**$139**
Functions	**$185**	**$139**
Data Windows	**$295**	**$249**
Complete 3 in 1 Pack	**$665**	**$475**

Shopping List for the Power Workbench

	LIST	US
ASSEMBLER		
Microsoft Macro Assembler with Utilities	150	109
PASM 86 *by Phoenix, Macro Assembler*	195	109
ASSEMBLER Support		
Btrieve Softcraft's File Manager	245	179
GSS CGI....*Device independent graphics*	495	425
BASIC		
Microsoft BASIC Interpreter..*for XENIX*	350	249
Microsoft QuickBASIC...*Ver 4.0*	99	66
Turbo BASIC.......*NEW from Borland*	100	75
BASIC LIBRARIES & UTILITIES		
Btrieve Softcraft's File Manager	245	179
GSS CGI....*Device Independent Library*	495	425
Halo Graphics by Media Cybernetics	325	249
C LANGUAGE COMPILERS		
C86 PLUS by Computer Innovations	497	397
Lattice C Compiler Now ver 3.2	450	299
Let's C Compiler from Mark Williams Co	75	55
Mark Williams C full development system	495	369
Microsoft C Compiler with free CODEVIEW	450	295
Microsoft QuickC....*Special Price*	99	66
Turbo C.......*New from Borland*	100	75
C LIBRARIES—Communications		
Asynch Manager by Blaise	175	135
Greenleaf Communications	185	139
Essential Communications	185	125
Essential Communications Plus	310	239
C LIBRARIES—FILE MANAGEMENT		
Btrieve Softcraft's File Manager	245	179
Btrieve/N File Management for Networks	595	449
Ctree by Faircom,with full source	395	299
Rtree...*Report Gen. for Ctree*	295	235
Ctree & Rtree.....*Special Combination*	650	499
dBC ISAM Accesses dBase files	250	175
with Source code	500	349
dBC III Plus multiuser	750	595
with Source code	1500	1195
Opt Tech Sort Super fast sort for Btrieve	149	105
XQL....SQL *from NOVELL*	795	595
C LIBRARIES—Graphics		
Essential Graphics...*no royalties*	299	225
GSS CGI....*Device independent graphics*	495	425
GSS Metafile Interpreter stores images	295	265
Halo '88 by Media Cybernetics	325	249
Halo for Microsoft Languages	595	434
C LIBRARIES—Screen Design		
Curses from Lattice,UNIX lookalike	125	99
with source	250	199
C Worthy....*by Custom Design Systems*	195	159
C Worthy with Forms	295	269
Greenleaf Data Windows	295	249
Microsoft Windows Dev. Toolkit	500	365
Panel Plus by Roundhill	495	395
View Manager for C,Blaise	275	199
Vitamin C...*Creative Programming*	225	198
VC Screen...*Source code Generator*	150	119
Windows for C	195	149
Windows for Data	295	259
Zview....*Data Management Consultants*	245	122
C UTILITY LIBRARIES		
Basic C....*Basic-like routines for C*	175	139
Blaise C Tools Plus/5.0....*f/MsC & QuickC*	129	99
Blaise Turbo C Tools...*f/TurboC*	129	99

	LIST	US
C Food Smorgasbord by Lattice	150	109
C Utility Library by Essential,300 functions	185	119
Greenleaf Functions	185	139
PforCe by Phoenix, vast library	395	199
OTHER TOOLS		
BASTOC...*JMI,Translates BASIC to C*	495	399
dBX Translator......*dBASE to C translator*	550	469
with Library Source	950	829
Pre/C....*by Phoenix, like UNIX lint*	295	289
PC-LINT..*by Gimpel, subset of UNIX Lint*	139	125
COBOL		
Micro Focus COBOL/2	900	795
Micro Focus Toolset	900	795
Micro Focus Personal COBOL	149	134
Microsoft COBOL inc. COBOL Tools	700	499
for XENIX	995	749
RM/COBOL...*by Ryan McFarland*	950	697
RM/COBOL 85...*ANSI 85*	1250	895
COBOL Support		
Btrieve Softcraft's File Manager	245	179
GSS CGI....*Device independent graphics*	495	425
Halo.......*from Media Cybernetics*	325	249
RM/Screens..*Screen generator*	395	335
RM/Net+ 5...*R/M COBOL networking*	300	249
DBASE & RELATED PRODUCTS		
Applications Plus....*Fox & Geller*	299	249
Brief & dBrief..*Editor/Macro lang for DBase*	275	229
Clipper.....*Nantucket's DBase Compiler*	695	449
DATA-p.........*Wallsoft*	60	50
dBC III Plus supports multiuser commands	750	595
with Source code	1500	1195
dBC ISAM...*accesses dBase files*	250	175
with Source code	500	349
dBX Translator......*dBASE to C translator*	550	469
with Library Source	950	829
dFlow.......*Wallsoft*	149	124
Documenter.......*Wallsoft*	295	244
FoxBase+ .....*Fox Software*	395	247
Multiuser version	595	397
QuickCode Plus........*Fox & Geller*	295	170
QuickEntry...........*Fox & Geller*	99	59
QuickReport..........*Fox & Geller*	295	170
UI Programmer....*Wallsoft*	NEW	CALL
FORTRAN Compilers & Utilities		
Btrieve: Softcraft's File Manager	245	179
GSS Graphics Development Toolkit....*CGI*	495	425
GSS GKS...*Kernel Sys,ANSI Level 2b*	495	425
Halo '88.......*from Media Cybernetics*	325	249
Microsoft Fortran..*Ver 4.0,inc. Codeview*	450	295
for XENIX	695	499
R/M Fortran...*ANSI 77 by Ryan McFarland*	595	499
for XENIX	750	599
Spindrift Library....*By Spindrift Labs*	149	129
PROLOG		
APT..*PROLOG Tutor*	65	59
Arity PROLOG Compiler & Interpreter	650	569
Arity PROLOG Interpreter	295	239
Arity Standard PROLOG	95	77
PROLOG-86 Plus.........*Solution Systems*	250	199
Turbo PROLOG...*Borland Intl.*	100	75
Turbo PROLOG Toolbox...*Borland*	100	75
TEXT EDITORS		
Brief......*from Solution Systems*	195	155
dBrief..*Macro lang for Brief & DBase*	95	79

	LIST	US
Brief & dBrief Combo	275	229
Condor Editor....*Condor Corp SUPER SALE*	130	65
Epsilon.....*Lugaru*	195	149
KEDIT.....*Mansfield..identical to XEDIT*	125	99
KEDIT Ver. 4.0	150	128
Pmate.....*Phoenix*	195	179
Vedit Plus.........*Compuview*	185	129
DEBUGGERS		
Advanced Trace 86.....*Morgan*	175	119
C-Sprite...*Source debugger for Lattice C*	175	139
Periscope I...*Board, Switch, Software*	795	749
Periscope II..*Breakout Switch & Software*	175	139
Periscope II.....*Software only*	145	105
Periscope III....*8 Mhz*	1095	875
Periscope III...*10 Mhz*	1395	1129
Pfix 86 Plus....*Phoenix symbolic debugger*	395	199
LOGITECH		
MODULA-2 Compiler Package	99	79
MODULA-2 Development Pkg	249	199
MODULA-2 Toolkit	169	139
MODULA-2 ROM Package	299	239
MODULA-2 Window Package	49	39
PHOENIX		
Pasm 86......*Macro ASSEMBLER*	195	179
Pdisk......*Disk Management Utility*	145	134
PFantasy.....*six-pack take-away*	995	799
PFinish......*Profiler*	395	199
PFix 86 Plus.Symbolic Debugger	395	199
PForCe.......*Utility library*	395	199
PforCe...*Pforce for C*	395	199
PLink 86+ ...*sophisticated overlay linker*	495	269
PMaker.......*make utility*	125	109
Pmate........*Text Editor*	195	179
Pre-C........*Super-set of UNIX Lint*	295	289
Ptel.........*Binary Transfer Program*	49	39
POLYTRON		
PolyBoost....*Software accelerator*	80	73
PolyDesk III..*3rd Generation Desktop org*	99	73
PolyLibrarian...*Library Manager*	99	89
PolyLibrarian II	149	129
PolyMake......*Complete MAKE Utility*	149	129
PolyShell.....*UNIX-like Command Shell*	149	109
PolyXREF2...*Cross Reference Util all lang*	219	189
PolyXREF2...*Single Language support*	129	118
PVCS Corporate...*Source Code Control*	395	329
PVCS Personal...*Personalised ver of above*	149	129
PVCS Network...*Powerful Ver. of PVCS*	Call	Call
RYAN McFARLAND		
RM/COBOL......*ANSI 74 Standard*	950	697
for UNIX or XENIX	1250	999
RM/COBOL 85.....*ANSI 85 Standard*	1250	895
RM/FORTRAN.....*ANSI 77 Standard*	595	297
for UNIX or XENIX	750	599
RM/NET+ 5...*COBOL Networking*	300	249
RM/Screens.....*COBOL 85 Screen generator*	395	335
SOFTCRAFT		
Btrieve Softcraft's File Manager	245	179
Xtrieve...*Query language for Btrieve*	245	220
Report Option for Xtrieve	145	128
Btrieve/N File Management for Networks	595	449
Xtrieve/N.....*Multi-User Query*	595	459
Report Option/N...*Multi-user Rep Opt*	345	269
XQL......*SQL for Btrieve*	795	595

HANSON & CONNORS'
PC EXCHANGE™*
1-800-DIAL-PCX
30 DAY MONEY BACK GUARANTEE

OVERNIGHT SOFTWARE DELIVERY
*Formerly PC EXPRESS

VISA MasterCard

(That's 1-800-342-5729)
All prices subject to change.
Delivery subject to availability.

7 ZEL PLAZA
SPRING VALLEY, NY
10977

PHONE: (914) 426-2400
FAX: (914) 426-2600
TELEX: 667962 (SOFT COMM NYK)

CIRCLE NO. 233 ON READER SERVICE CARD

PROGRAMMING PRODUCTIVITY TOOLS

ESSENTIAL C UTILITY LIBRARY

400 Functions, 30¢ Each

You've probably seen the speed and power of Essential's C function library without knowing it. Software greats have been using it for some time to give today's top products pizazz and panache.

Now grown to 400 functions Essential produces pop-up menus, save and restore screens and windows to disk or memory in as little as 1/10th second, and the fastest video output available. Library has a complete set of 50 business graphics functions, 40 string handlers, 28 functions for printers, 18 for mice, 11 for time and date. DOS interfacing functions offer disk error trapping, directory and file management. Everything in source, including sample programs that demo library functions. We have versions with pre-built libraries for all well-known C compilers, and a source code librarian is supplied for rolling your own.

	List:	PC Express
C Utility Library	**$185**	**$119**
Essential Graphics	**$299**	**$225**
Essential Communications	**$185**	**$125**
with Breakout Debugger	**$310**	**$239**

C-TREE & R-TREE

B-Tree File Manager Now Has Report Generator

c-tree: The only major b-tree file manager with network support in the standard low-cost version. c-tree™ gives you record-locking routines for DOS 3.1/3.2, UNIX and XENIX, and it even comes in C source code, yet there are no royalties. Source sticks to K&R, so c-tree is portable. Tests in many environments prove it.

Permits any number of keys for a data file—alpha, numeric, even floating point. Handles files with varied record lengths, multiple keys in one index file. Both high level and decomposed functions. It's the works.

	List:	Ours:	Combined:
c-tree:	**$395**	**$299**	**$499**
r-tree:	**$295**	**$235**	

r-tree: Adds the ability to produce ad hoc reports from files maintained by c-tree (v. 4.1 and up). Link a file description to the r-tree™ library, and use any text editor to write report scripts with no further C coding. Reports can access data in several files, select on criteria, join findings into new logical records, sort them, calculate new fields and columns, tabulate by control breaks. Comes in source, same portability as c-tree, and fits any compiler.

WINDOWS for DATA

M'soft Windows Compatible

"Onlt one package can be easily recommended" said *Computer Language* (June '87) reviewing nine window and data entry products for C. Complete field level functions specify prompt string, field length, data type, screen location, picture, target variable, entry rules, help messages, even functions to call for validation once data keyed in.

Windows for C is a subset. No data entry but all windowing functions. Unlimited windows can be made either to pop up or permanently overwrite the screen, scroll and highlight lists vertically and horizontally. Specify Compiler. Windows for Data: List **$295**, Ours **$259**. Windows for C: List **$195**, Ours **$149**.

BLAISE C TOOLS PLUS/5.0

C TOOLS PLUS/5.0 from Blaise Computing Inc. helps you to quickly build professional applications using the full power of Microsoft C 5.0 and QuickC. Now you can concentrate on program creativity by having full control over DOS, menus, interrupt service routines, memory resident programs, fast direct video access; windows; printer and keyboard control, and more!

Blaise Computing's attention to detail, like the use of full function prototyping, cleanly organized header files, and a comprehensive, fully-indexed manual, makes C TOOLS PLUS/5.0 the choice for experienced developers as well as newcomers to C.

C TOOLS PLUS/5.0 prebuilt libraries are ready to use with either QuickC or the Microsoft C 5.0 command line environment. Complete documented source code is included so that you can study and adapt it to your specific needs.

	List:	PC Express:
C TOOLS PLUS/5.0	**$129**	**$ 99**
Turbo C TOOLS	**$129**	**$ 99**
C ASYNCH MANAGER	**$175**	**$135**
Turbo POWER TOOLS	**$ 99**	**$ 75**
Turbo ASYNCH PLUS	**$ 99**	**$ 75**

PANEL PLUS

Library Source Code Gives It Complete Portability

There are no end of tools for screen design and data entry, but none quite like Panel Plus. Design a screen under program control, use Panel's utility to "run" and test it field by field, then pass it to Panel's code generator which delivers C source code. Options style the code to your compiler's liking, and you can of course do what you like to the source afterward. The code calls Panel Plus's function library, but now *the library comes in source*, so everything produced is highly portable. Not like other screen managers delivered as object libraries and which leave *you* to write the detailed code.

Panel Plus will operate in graphics mode via interfaces to graphics products it supports and can utilize the EGA's 43-line screen. Low-level I/O functions adapt it to various keyboards, screens, operating systems.

Panel's newest incarnation has every imaginable feature. A single screen design can have 1000 fields stacked as visual overlays up to 127 levels deep or as pop-ups. Groups of fields can be moved between levels. Screens can be output as compilable code or stored on disk for loading at run-time. Each field can be boxed, colored, multi-row, word-wrapped, and scrolled horizontally and vertically if larger than its on-screen view aperture. It can be assigned its own help and error message, can be told to accept certain characters, or to match a picture, and to check data after entry—proper dates, number ranges, etc.—using Panel's or your own validation routines. You can add your routines to Panel's test utility because even it comes as source. Fields are accessed in any order and control reverts to your application program after each field for choice of action.

For past Panelists, the new version has smaller and faster field and screen functions, tighter granularity, and an enhanced, redesigned library. Major tool for the serious developer. List: **$495**, PC Express: **$395**.

POLYTRON VERSION CONTROL

Source Code Control for Any Language

PVCS allows programmers, project managers, librarians and system administrators to control the proliferation of revisions and versions of source code in software systems. Independent programmers, the leading software publishers and LAN companies, and hundreds of Fortune 1000 companies rely on PVCS to store and retrieve multiple revisions of text. It maintains a complete history of revisions as an "audit trail", generates status reports, and uses intelligent "difference detection" to minimize disk space for each new version.

On Corporate and Network PVCS simultaneous changes to a module are merged into a single new version. If changes conflict, the user is notified.

The "Logfiles" used to track changes are interchangeable between any PVCS product.

Corporate PVCS is for multiple programmers. It includes "branching" to maintain code when programs evolve on multiple paths. Personal PVCS offers most of the power and flexibility of corporate PVCS, but excludes multiple programmer features. Network PVCS is the Corporate version for LANs. File locking and security levels can be tailored to each project.

Ask for:	List	PC Brand:
Personal PVCS	**$149**	**$129**
Corporate PVCS	**$395**	**$329**
Network PVCS	**Call**	**Call**
PolyMake	**$149**	**$129**

C-WORTHY INTERFACE LIBRARY

The C-Worthy™ Interface Library wraps an entire user interface around your application. Its full power can be summoned by only a few high level calls. Sound exaggerated? A single function call can set up a complete text editor in a screen window. Recently acquired by Solution System, over 600 pages of Documentation, Turbo and Quick C version and a complete Interface Library have been added.

- High level calls pop menus and scrollable choice lists to the screen, restoring the background when dismissed.
- Windowing facilities open portholes of up to screen size for viewing virtual screens larger than the physical screen.
- Full context-sensitive help screen management takes over these chores and error messages. Automatic routines interrupt with pageable text windows explaining what to do next.

Novell found it "played a key role and accelerated development" in making its NetWare™ utilities easier for users. Ingenious demo: call for it.

Ask for:	List:	PC Express:
C-Worthy	**$195**	**$159**
with Forms Library	**$295**	**$269**

dBC *Identical dBASE III Plus Files Using C*

dBC™ is a series of C libraries from Lattice which creates, accesses and updates files identical to those of dBASE itself. So dBASE can read and update the files too.

What for? It means both C and dBASE applications can operate on the same data bases interchangably. It means C programmers can interface with the big market of dBASE users out there, yet side-step the dBASE language. It means dBASE applications can now be linked to the universe of C libraries and tools to add windows, graphics, statistical analysis, all the things dBASE cannot do. It means the speed and power of C to impress clients accustomed to dBASE!

dBC's functions parallel all dBASE's file handling commands, many decomposed to permit direct data manipulation. Our versions of dBC mimic file formats for dBASE II and III and now dBASE III Plus makes your programs network ready!... as many stations as a network allows. Hands-off mode handles record and file locking and unlocking automatically. Close in functions give you direct lock/unlock control.

Supports all four memory models. dBASE II, III...List: **$250**, Ours: **$175**. dBASE III Plus...List: **$750**, Ours: **$595**. Call for Source Code Pricing.

Payment: We honor MasterCard, Visa, American Express (no surcharge), checks in advance, or funds wired to PC Express, c/o Chemical Bank, 126 East 86 St., New York, Account 034-016058. COD (U.S. only) for cash, money order, certified check (no fee). NY State, add sales tax. Purchase orders accepted from larger corporations and institutions at our discretion if you agree to net 30 days plus 2% a month late penalty thereafter.
Shipping & Handling: U.S.: UPS Surface: 1st product $6, each add'l $3. UPS 2nd Day Air: 1st product $12, each add'l $6. UPS Next Day Air and Federal Express shipment costs based on weight. International: Charges vary by destination and carrier. $10 per shipping container for export forms. Air parcel post at your risk beyond collected insurable amount.

THE SPINDRIFT LIBRARY

Fully Functional Fortran Library.

Spindrift's smooth package offers something previously unavailable to the Fortran buffs...a basket of functions, packed to the brim. No more tedious coding. Just call on Spindrift with it's armoury of functions.

Any number of Windows may be defined, each with a striking border and brilliant color. Define "pop-up" screens, Save/Restore images, set Cursor shape. Snare an entire screen into a Character array.

The Keyboard; read it without echo, or sense any keypress during execution. Cursor controlled directly with Edit keys.

DOS interface includes: Call System, Call Exec, Findfrst/Findnext for (*) and (?) file searching. Search the Path, subdirectory and file manipulation, command line argument parsing, date/time functions, DOS environment access, and much more. Other utilities also included.

Specify compiler, Microsoft or Ryan McFarland. List: **$149.00**. Us: **$129.00**

HANSON & CONNORS'
PC EXCHANGE™* **1-800-DIAL-PCX** **30 DAY MONEY BACK GUARANTEE**

OVERNIGHT SOFTWARE DELIVERY
*Formerly PC EXPRESS

VISA MasterCard

(That's 1-800-342-5729)
All prices subject to change.
Delivery subject to availability.

7 ZEL PLAZA
SPRING VALLEY, NY
10977

PHONE: (914) 426-2400
FAX: (914) 426-2600
TELEX: 667962 (SOFT COMM NYK)

PC EXCHANGE PROGRAMMER'S WORKBENCH

dBASE AT THE SPEED OF C

dBx Translates dBASE Applications to C

You dBASE™ programmers know what an expressive and readable language dBASE is. It's a very comfortable development environment. But the price is debased performance. Even compiled dBASE doesn't offer the speed that some users require these days. The kind of speed offered by software written in the C language. The answer is dBx™.

dBx translates dBASE to C. It offers you a major competitive advantage over the next dBASE programmer: Keep writing in dBASE. Take every application all the way to completion. Then use dBx to translate them top to bottom to C!

Other advantages: C is portable, even to other operating systems like UNIX/Xenix™. To the Macintosh or Amiga. dBx gives your applications a passport to places dBASE cannot go.

Has its own file manager for single user, but links to major C file managers—c-tree and dBC—for compatibility with dBASE files or multi-user support. We have everything you'll need, including good advice.

	List:	Ours:
dBx	**$550**	**$469**
with Library Source	**$950**	**$829**
Call for Full Source Pricing		

BRIEF/dBRIEF

The Power Environment for dBASE Programming

Many worthy utility products supply needs that dBASE®'s programming language doesn't—dUTIL™, dFLOW™ and a host of others. Trouble is, you have to use them separately, then combine their output into your dBASE program files.

No longer. dBRIEF™, written in BRIEF's macro language, grabs hold of BRIEF and turns it into a complete dBASE III and III Plus programming domain. Using BRIEF's underlying shell capabilities and its own interfaces, dBRIEF can run external utility libraries, plus dBASE itself, and link to the Clipper™, Foxbase+™ and Quicksilver compilers, all with dBRIEF still loaded and running the show. It can do what BRIEF already does plus:

- Convert a screen layout into dBASE code for interactive data entry.
- Display dBASE file structures in windows, a great convenience alongside your program files.
- Expand keystrokes into full dBASE statements.
- Indent automatically for clegic display.
- Create databases; index files; invoke Ashton-Tate's dFORMAT™ and dCONVERT™; draw lines and boxes.

"Simply marvelous programming environment for writing and editing dBASE programs.", *PC Magazine*, 7/86. Source code included!

Requires BRIEF 1.32 or later and 384k; 512k to run dBASE within dBRIEF; 640k and harddisk recommended.

BRIEF/dBRIEF...List **$275**, Ours: **call**

FOXBASE +2.10

The Fastest, Most Powerful, dBASE Compatible Database Management System, NOW!

New, **FOXBASE +2.10** is faster, and more powerful than dBASE IV...and it's available NOW! FOXBASE +2.0 is already a PC Magazine Editor's Choice...and has received an unbelievable 9.2 rating from Infoworld. FOXBASE +2.1 has new features such as built-in support for pull-down and pop-up menus, a new screen painter to create custom input screens, a new advanced automatic applications generator to write programs for you automatically, a new user interface designed to allow both first-time and experienced users to handle most database options effortlessly...and, much, much more... plus, Foxbase is still dBASE compatible and contains hundreds of dBASE enhancements. Run almost any dBASE program without modification. Foxbase fully supports commands like Browse, Edit, Append, Create, Modify, Report, and Modify Label, even in the middle of a compiled program! Foxbase supports EMS memory and local area networks.

	List:	Ours:
FoxBase +Version 2.10	**$395**	**$247**
Unlimited Runtime	**$500**	**$333**
FoxBase +Multi-User (LAN)	**$595**	**$397**
Unlimited Runtime	**$700**	**$467**
FoxBase +/386	**$595**	**$397**
Unlimited Runtime	**$500**	**$333**
FoxBase +Macintosh	**$395**	**$263**
Unlimited Runtime	**$300**	**$201**

MICROSOFT LANGUAGES

Powerful Implementations Of The Most Popular Programming Languages

Microsoft C 5.0: The flagship of the Microsoft line runs up to 30 percent faster than its predecessor. Its new optimization features deliver untouchable execution speeds, 100 new additional library routines...

Microsoft MacroASSEMBLER 5.0: If you ever wanted to take on the challenge of assembly, here's your opportunity. "MASM" 5.0 is a lot easier to use, has completely revised documentation, and a new "Mixed Language" programming guide that gives you step by step instructions for linking your assembly code with other Microsoft languages.

Microsoft QuickBASIC 4.0: is a revolutionary concept in BASIC programming. It allows you to run, edit, debug, and run again. Our friends at Microsoft have eliminated the dreaded compile step. Whenever you edit your code QB4 automatically incorporates your changes, so that it can run a program of 150,000 lines in less than a minute.

Each member of this language family includes the renowned debugger CODEVIEW.

	List:	Ours:
Microsoft C	**$450**	**$295**
Microsoft Macro-ASSEMBLER	**$150**	**$109**
Microsoft QuickBASIC	**$ 99**	**$ 66**
Microsoft FORTRAN	**$450**	**$295**

NOVELL: BTRIEVE, XQL, XTRIEVE

Sophisticated Tools Essential For Fast Database Handling

Btrieve is a library of subroutines that allows the programmer to build a database application using any language. It takes complete charge of all file creation, indexing, reading, writing, insertion, deletion, forward and backward searching. Its balanced tree indexing scheme finds any key in a million in less than 4 accesses...That's fast!

Btrieve is multi-lingual also. It includes more than 20 language interfaces (including C, BASIC, PASCAL, FORTRAN). However if it turns out that you are using something a little unusual, worry not. The manual includes a chapter on how to write a language interface to Btrieve.

Btrieve's vital statistics are equally impressive. Files may have up to 24 indexes; fixed record length to 4090 characters; variable length to 64K; indexes to 255 characters; files of 4 billion bytes. Network support includes Novell, 3-COM, IBM PC NET, Software Link's Multilink and many others.

XQL is a relational database management system designed especially for programmers. Imagine being able to access your database with the ease of SQL (Structured Query Language) statements and still having the power to process that data right down to the byte level.

Think about your applications. A large part of your software development effort is probably devoted to managing data stored in files on disk. Hours spent writing lines of code to search and store data records could have been used to program more important parts of your application. Why not let XQL do it for you. XQL will increase your programming productivity and let you focus on building better applications.

The XQL system works in tandem with Btrieve and has an equally powerful chassis...No limit on the number of records per file. Max. file size is 4 gigabytes, Max. record size equals 4K, Max. indexes per file is 24. The one version works for single or multiuser systems, DOS Ver 3.0 or greater. All languages are supported.

Xtrieve is the final ingredient in the Novell programming recipe. It is a menu driven, data retrieval system, that allows you to quickly find information and display reports. System developers can easily customize Xtrieve to display command menus, help files, and error messages in the English spoken by the customer. Xtrieve screens then gives menu choices that users can quickly recognize, making Xtrieve an easy product to use and understand.

Report Option for printing customized reports, form letters, mailing labels & statements.

	List:	Ours:
Btrieve	**$245**	**$179**
Btrieve/N	**$595**	**$449**
XQL	**$795**	**$595**
Xtrieve	**$245**	**$220**
Xtrieve/N	**$595**	**$459**
Report Option	**$145**	**$128**
Report Option/N	**$345**	**$269**

GSS GRAPHICS SYSTEM

Leave the Device Driving to GSS

For serious applications stick to the tools that stick to the standards. Not the least of reasons why GSS™ has emerged as the pre-eminent graphics toolmaker is that it has always conformed to ANSI standards.

At the heart of the system is the CGI standard Development Toolkit. It has all language interfaces and device drivers for keyboards, mice, joysticks, tablets, printers, plotters, cameras. The drivers completely insulate your application from concern for device idiosyncracy.

GSS Kernel™ conforms to ANSI's GKS 2b and has all its drivers and language bindings. Macro level tools to draw, color, segment, transform, store and recreate an object. The Metafile Interpreter reads ANSI CGM files with full CGI capability for recreation on various devices.

Quality software? IBM thinks so. They sell GSS under their own label. Royalties. Needs 256k.

	List:	Ours:
CGI Dvlpment Toolkit	**$495**	**$375**
Kernel System	**$495**	**$375**
Kernel for IBM RT	**$795**	**$645**
Metafile Interpreter	**$295**	**$235**

CLIPPER $449

R&R RELATIONAL REPORT WRITER $129

MORE PROGRAMMING TOOLS FOR...

dBASE, C, FORTRAN, BASIC, COBOL, PASCAL

dbc ISAM, FoxBASE, Greenleaf, Halo '88, Logitech MODULA, MicroFocus COBOL, Norton Utilities, Panel Plus, Periscope, Phoenix, Polytron, RM/COBOL, Sprindrift, Tom Rettig's Library, Windows for Data...and many more.

Call or write for prices and information.

HANSON & CONNORS'

PC EXCHANGE™* **1-800-DIAL-PCX** 30 DAY MONEY BACK GUARANTEE

OVERNIGHT SOFTWARE DELIVERY

*Formerly PC EXPRESS

VISA MasterCard American Express

(That's 1-800-342-5729)
All prices subject to change.
Delivery subject to availability.

7 ZEL PLAZA
SPRING VALLEY, NY
10977

PHONE: (914) 426-2400
FAX: (914) 426-2600
TELEX: 667962 (SOFT COMM NYK)

CIRCLE NO. 233 ON READER SERVICE CARD

THE PROGRAMMER'S SHOP

helps save time, money, and cut frustrations. Compare, evaluate, and find products.

FREE Spring '89 Catalog

Quality for a 10% Discount or FREE Software! Find products fast. Choose from over 700 popular titles.

- Over 90 new products
- New OS/2 section
- Completely updated versions, descriptions, and pricing
- Most popular products of 1988 highlighted

Get help finding the tools you need. Call 800-421-8006.

Mention "PT489"

New Discoveries

Clear+ for C

by Clear Software. C source diagramming and analysis. Menu-driven. Logic analyzer reports inconsistencies and syntax errors. Tree charts, program flowcharts, formatted source listings. Output to screen, printer, or file. Preprocessor support, program simulation. Turbo, MS C support. $179

QuickC 2.0

by Microsoft. Features faster (2-3x) incremental compilation and linking, integrated assembler, extensive hypertext-based on-line help. Support all memory models from within integrated environment. CGA/EGA/VGA/Hercules support. $69

Mention "PT489"

Featured Product

FORTRAN to C Translator

FOR_C by Cobalt Blue. Converts F77 to readable C, with I/O translations. MILSPEC and VAX77 extensions supported. C source to runtime libraries included. $679

386 Development Tools

	List	Ours
386 Assembler/Linker	495	399
386 Max	75	69
FoxBASE+/386	595	399
High C - 386	895	Call
Hoops/386-32	575	489
Lahey Fortran F77L-EM/32	895	Call
NDP C-386	595	539
VM/386	245	209

AI-Expert Systems

Exsys Professional	795	695
Personal Consultant Plus	2950	2589

AI-Languages

ARITY Combination Package	1095	979
PC Scheme LISP - by TI	95	79
TransLISP PLUS - call MSC	195	119
TURBO PROLOG V2.0	150	115
Turbo Prolog Toolbox	100	75

Assemblers

MS Macro Asm	150	105
Turbo Assembler/Debugger	150	115
Visible Computer 80286	100	89

BASIC & Addons

Exim Toolkit	100	85
MS QuickBASIC V4.5	99	75
QBase	99	89
SoftCode Generator - Templates	50	45
True Basic	100	Call
QuickPak Professional	149	129

C Language - Compilers

AZTEC C86 - Commercial	499	Call
High C-286 - by MetaWare	595	Call
Instant C/16M	795	699
Lattice C - V3.4	450	289
Microsoft C 5.1 - w/CodeView	450	299
Microsoft QuickC	99	75
w/serial mouse	199	149
Turbo C - by Borland	150	115
Turbo C Professional	250	179
Watcom C6.5 - highly optimized	295	Call

C Utilities

C+O Class Library	195	179
with source code	444	399
CQL - SQL for ctree	395	339

CASE & Prototypes

Dan Bricklin Demo II	195	179
Design/OA - graphic design	7500	Call
Interactive EasyFlow	150	119
Matrix Layout - flow chart	150	139
MetaDesign by Meta Software	350	329
Show Partner F/X - demos	395	339

COBOL

MS COBOL V3.0 - OS/2	900	599
Realia COBOL	995	849

Communications Addons

C Asynch Manager - Blaise	175	135
Essential Comm Library	185	159
Greenleaf Comm Library	229	169

DataBase Mgmt.

Advanced Revelation	950	779
CLARION - complete envt.	695	589
DataFlex - by Data Access	695	599
Eagle - by Migent	495	419
Magic PC - visual database	299	259
Paradox V3.0	725	539
R:BASE for DOS	725	539

Dbase

	List	Ours
Clipper Summer '87	695	469
D the data language	395	359
dBASE IV	795	Call
dBMAN V	190	179
DBXL Interpreter	199	149
FoxBASE+ - V2.1	395	249
QuickSilver Diamond	599	379

Dbase Addons

CodeBASE	194	179
dBASE Tools for C	90	75
dGE - business graphics	195	179
dQuery	150	139
FLIPPER Graphics Library	195	179
IDL Integrated Devt Library	149	135
SilverComm Library	150	139
SoftCode w/dBASE templates	80	69
Tom Rettig's Library	100	79

See us at COMDEX/Spring '89

April 10–13, 1989

McCormick Place

Chicago, Illinois

Booth #7570

Dbase Tools

CLEAR+ for dBASE	200	159
Buzzwords Toolboxes	295	249
Dbase Online - 6 pop-up refs.	99	89
dBRIEF w/BRIEF	275	Call
dBug - source debugger	195	179
dBX - dBASE III to C	550	529
Genifer - code generator	395	259
Scrimmage by IDL - screen/menu	149	119
Sycero db - single user	495	479
R&R Relational Reportwriter	149	119
UI Programmer	295	239

Debuggers

Periscope II - breakout switch	175	139
Periscope III - 10 MHz version	1395	1119
Sourcer	100	89

Development Tools

Instant Replay - Nostradamus	150	139
MKS AWK	99	89
MKS Lex & Yacc	249	219
MKS RCS	189	169
PC-Lint	139	109
PC-Metric - analyze	199	189
Plink 86 Plus - overlays	495	299
PolyMake	149	135
PVCS Corporate	395	369
Source Print	97	89

Editors

BRIEF	195	Call
Edix	195	159
Epsilon - like EMACS	195	159
KEDIT - like XEDIT, V.4	150	125
Personal Rexx	125	109

Editors Cont.

	List	Ours
PI Editor	195	159
SPF/PC - V2.0	245	189
Vedit Plus	185	129

File Addons

Btrieve ISAM - V5.0	245	185
Btrieve/N - multiuser	595	455
Report Option	145	119
XQL - SQL for Btrieve	795	599
Xtrieve	245	189
c-tree by Faircom - source	395	315
d-tree - data dictionary	495	399
r-tree - report generator	295	239
c-tree - w/r-tree	650	519
CBTREE - Source	159	139
C-Index Turbo	99	85
dBC ISAM III - by Lattice	250	169
dB_FILE - network model	Varies	Call
dB_FILES - by Software Connection	99	79
dB_RETRIEVE - SQL	Varies	Call
Opt Tech Sort	149	119
WKS Library	195	179

FORTRAN

FOR_C - FORTRAN '77 to C	750	679
I/O Pro - screens	149	129
Lahey FORTRAN F77L	477	429
Lahey FORTRAN F77L-EM/16	695	629
Lahey Personal FORTRAN	95	89
MS FORTRAN - CodeView	450	299
Spindrift - DOS, windows	149	129

General Addons

C Tools Plus - V5.0	129	99
C Utilities - by Essential	185	139
Greenleaf Functions	209	159
Greenleaf SuperFunctions	265	199

Graphic Addons

Essential Graphics	299	229
with source	598	499
Greenleaf Makeform-DOS	170	149
GSS Dev't Toolkit	620	549
Halo '88 - 140+ devices	325	229
Hoops 3D Graphics	575	499
MetaWINDOW	195	159
MetaWINDOW/PLUS	275	229
PCX Programmer's Toolkit	125	109
with source	190	169
Pizazz	60	55
Pizazz Plus	149	129
Turbo Plus - Nostradamus	150	139

Obj.-Oriented

	List	Ours
Actor	495	439
Smalltalk/V	100	85
Smalltalk/V 286	200	169
Zortech C++ - true compiler	150	Call

OS - Support

MS Windows/286	99	75
MS Windows/386	195	149
Development Toolkit	500	369
MKS Toolkit - Unix shell	199	169
OS/2 Programmer's Toolkit	350	259

Other Languages

IntegrAda	795	749
Modula-2 Dev. System	249	199
RPG II complete	1400	1299
TopSpeed MODULA-2 3 Pack	180	Call
TopSpeed MODULA-2 Compiler	100	89

Other Products

AEWindows	225	139
Auto-Might by Pendulum Group	70	65
CO/SESSION	249	219
dQuery/Lib	295	279
Evertrak	295	Call
FM-Plus	100	89
Link & Locate++ - ROM MSC	395	349
Math Advantage	495	459
MKS VI - VI for DOS	149	129
Norton Utilities Advanced	150	109
OPTune - disk optimizer	100	89
PC Tools Deluxe	80	75
PROTEUS Prototype System	149	129
SoftProbe II/TX - debug	395	345
Zap - file xfer	95	89

Text Screen Addons

C-scape	399	379
C Worthy w/forms	295	Call
Curses - by Aspen Scientific	119	109
with source	289	275
Greenleaf DataWindows	295	219
for OS/2	395	299
Hi-Screen XL	149	129
Hyperinterface - FTN, C, BAS, PAS mem	100	89
SoftCode Generator - C templates	50	45
Vitamin C - source, menus	225	169
for OS/2	345	279
VC Screen - painter	149	119
Vermont Views - replaces WFD	395	349
with source	790	659

Pascal

SoftCode Generator - templates	50	45
Turbo Analyst	99	89
Turbo Meta-Menu w/source	224	209
Turbo ASYNCH PLUS	129	99
Turbo Pascal 5.0 by Borland	150	109
Turbo Pascal 5.0 Professional	250	179
Turbo POWER TOOLS PLUS	129	99
Turbo Professional	125	109
Turbo Programmer	549	449

Unix/Xenix

DosMerge 286	249	219
DosMerge 386	499	479
Edix - editor	275	239
JAM JYACC Applic. Mgr.	many	Call
Microport System V/286	649	599
Microport System V/386	899	799
SCO Xenix System V 286	1295	999
SCO Xenix System V 386	1595	1299
Turbo ASYNCH PLUS	129	99

Note: Mention this ad. Some prices are specials. Ask about COD and POs. Formats 3" laptop now available, plus 200 others. UPS surface shipping $4/per normal item. Prices subject to change without notice.

Established 1983. We carry over 1,100 *different* products. Call today for complete technical information and advice, our catalog, literature, and *solid value.*

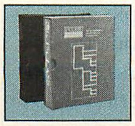
5-P Pond Park Road
Hingham, MA 02043
Mass: 800-442-8070
or 617-740-2510 2/89
Telex: 671-5348
FAX: 749-2018

800-421-8006

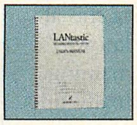
HOURS:
M-F 8:30 - 8:00
Sat: 10:00 - 4:00

PRODUCT WATCH

Reviews and Updates



1ST-CLASS
1st-CLASS Expert Systems Inc.

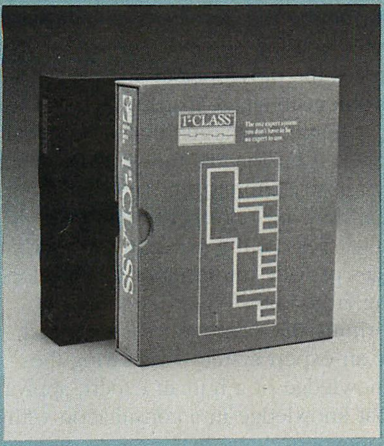


LANTASTIC 2.49
ARTISOFT Inc.

1ST-CLASS

1st-CLASS Expert Systems Inc.
526 Boston Post Road
Suite 150 East
Wayland, MA 01778
800/872-8812; 508/358-7722

PRICE: $ 495, 1st-CLASS 3.63
$1,495, 1st-CLASS Fusion 1.35



CIRCLE 344 ON READER SERVICE CARD

Reasonable cost and ease of use are two major requirements for any software package to be successful. Expert-system shells are no different. Because expert systems generally are less understood than other data-management tools, ease of use may be more important than price.

1st-CLASS Expert Systems Inc., creator of the 1st-CLASS and 1st-CLASS Fusion expert systems, obviously had these requirements in mind. Both packages use point-and-shoot and other spreadsheet paradigms to make building and running an expert system as uncomplicated as possible. Priced at $495 and $1,495, respectively, they are considerably more affordable than either workstation-based or even some high-end, DOS-based expert-system shells.

Although the two products are similar in operation, 1st-CLASS Fusion has more features and handles larger problems. Both, however, have virtually the same look and feel of a spreadsheet. Listed across the top of each screen are the commands that can be entered from that screen. Another row lists function-key assignments and the current file name. The remainder of the screen displays spreadsheet-like screens, except for the bottom line, which is reserved for messages.

A FIRST-CLASS DEVELOPER

In traditional expert-system methodology, a knowledge engineer interrogates a human expert about a knowledge domain and, using an expert-system shell, creates a knowledge base or a set of rules. (For an explanation of expert-system shells, see "Computerized Reasoning," Tom Arcidiacono, May 1988, p. 44.) 1st-CLASS provides these same capabilities. A developer can use the package to develop and execute a knowledge base or a system of chained knowledge bases. An Advisor program, included with the package, allows users to execute the knowledge base in an advisory mode only.

With 1st-CLASS, the developer creates a knowledge base in six steps, each corresponding to a screen. The first step is to select a name for the knowledge base from the Files screen, where the developer also can retrieve and print files and display a road map of knowledge bases that consists of several files. Pressing the F10 key moves to the next screen. The function of F10 is consistent throughout the program, as is the use of F9 and F1; F10 moves forward one screen, F9 moves backward, and F1 invokes an on-line, context-sensitive help facility.

The next step in creating a knowledge base is specifying its elements. A 1st-CLASS knowledge base consists of a single rule or decision tree. The rule consists of factors that correspond to decision points and results.

Once element definition is complete, the developer enters the various combinations of example factor values and corresponding results with the Examples screen. The Examples screen is used like a spreadsheet—the arrow keys move a highlight bar from one cell to another, for entering and editing factor and result values.

The fourth step in creating a knowledge base is to build the rule using one of four methods: optimizing for the fewest questions, executing rules in the defined order, matching user responses to questions, or customizing or modifying rules with the package's Rule Editor. The Rule Editor will also add, change, or delete results and delete or build factors.

The next screen, and the fifth step in creating a knowledge base, permits the developer to analyze the rule by displaying it in the form of a knowledge tree—lines join factors with corresponding values. When the developer positions a highlight bar on a factor, the associated question is displayed at the bottom of the screen, where the rule can be edited or printed.

The final step is to test the knowledge base by running the Advisor program. The program asks each question in turn and displays a result when the rule tree is traversed. If the knowledge base does not perform as desired, the developer can backtrack to earlier screens to debug or fine-tune the rule.

A knowledge base or rule is limited to 32 factors, 128 results, and 255 examples. Although a 1st-CLASS expert system cannot solve complex problems within these limits, the developer can chain knowledge bases together. That is, a result in one rule may be chained to another knowledge base—*forward chaining*, in 1st-CLASS terminology. Chaining also replaces a factor with a separate knowledge base; instead of asking a question, 1st-CLASS can call another knowledge base. This chained

knowledge base returns one of the allowable values to the calling knowledge base. If used properly, chaining allows the construction of virtually unlimited expert systems.

1st-CLASS also can call external programs to perform tasks that are not easily performed internally. A rule might call an external data manager, for example, to look up a value, or call a FORTRAN program to perform complex calculations. These external programs can return values, display graphic screens, or produce printed reports. 1st-CLASS includes several examples of external programs written in Borland's Turbo Pascal.

Using the Advisor program, knowledge bases also can serve as logic engines for other programs. A batch file can call an Advisor session and return results through the ERRORLEVEL mechanism. A more-powerful method is to EXEC the Advisor program from within another program. Advisor can run in the normal mode, in which it conducts a dialog with the user, or in a silent mode, in which all screen output is suppressed. The latter mode allows the outer program to conduct the dialog with the user and the Advisor to act as the logic engine.

1st-CLASS Fusion operates in essentially the same manner as 1st-CLASS but has several enhancements. For example, Fusion uses math expressions, directly accesses dBASE III database files, and supports graphics.

The text associated with a factor can include executable statements—assignment statements in curly braces. This facility is limited to simple arithmetic operations—no trigonometry or matrix operations. Nevertheless, Fusion allows more control of numeric values than does 1st-CLASS.

1st-CLASS Fusion's facility for accessing dBASE III database files includes a SEEK command for finding a record based on field values and a GET command for reading field values. PUT updates a field in the current record and APPEND adds a record. The list of commands is limited, but the facility provides a straightforward method of linking Fusion knowledge bases to database applications.

The developer can include graphics screens in knowledge bases with Fusion's screen capture and display programs. These two programs, Capture and Pic, support CGA, EGA, and VGA graphics. Capture is generally used outside Fusion to capture images created with other programs. PIC, Fusion's stand-alone display program, ensures that images are either captured correctly or called from Fusion to display graphics images at various points in an Advisor session. Graphics screens can be associated with function keys to be used as optional help screens.

The Fusion package also includes the runtime version (FRUN), the counterpart of Advisor. FRUN executes a knowledge base built with Fusion, while denying the client-user access to the development screens or the structure of the knowledge base. Both FRUN and Advisor can be distributed along with user-developed knowledge bases on a royalty-free basis.

WHAT IF . . . ?

The spreadsheet interface encourages the same what-if approach to rule construction that spreadsheets have brought to financial analysis. A developer can quickly cycle from the definition screen to the rule screen and back, changing factors, factor values, examples, methods, and results—tuning the rule until it produces the same results as the human expert.

As a result, the programs are particularly useful during the initial analysis of a problem and may reveal that some factors are not required in a rule, even though human experts may feel the factors are significant.

Although the maximum size of a 1st-CLASS rule is small in comparison to the knowledge bases of larger systems, chaining allows the construction of large composite knowledge bases. Moreover, the size limitation on individual rules does have some benefits—the program can be very responsive, permitting the developer to build large rules in a few seconds; the size also forces the developer to analyze the problem in small, manageable chunks.

Some may argue that 1st-CLASS and 1st-CLASS Fusion are not genuine expert systems (meaning, among other things, that they are not priced high enough). Regardless of the price, the two packages provide the facilities for developing large knowledge bases and performing the essential tasks expected of an expert system—capturing the knowledge of a human expert, applying that knowledge in a consultation with a nonexpert client, making a recommen-

dation, and explaining the reasoning that led to the formulation of the recommendation.

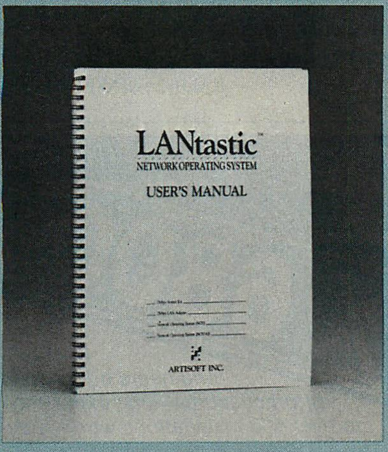
Conceding that more-powerful expert systems are available does not make these two programs less attractive. Both 1st-CLASS and Fusion are more than adequate for advisory tasks that do not justify a large expert system complete with knowledge engineer, LISP workstation, and so on. Any operation that includes a PC for other routine tasks—such as selecting shipping methods and materials, checking expense vouchers, cost estimating, purchasing, or computer-aided design (CAD)—is a candidate for a 1st-CLASS or Fusion Advisor program.

—VICTOR E. WRIGHT

LANTASTIC 2.49

ARTISOFT Inc.
3550 N. First Avenue, Suite 330
Tucson, AZ 85719
602/293-6363

PRICE: $495 (120-node LAN license)



CIRCLE 345 ON READER SERVICE CARD

LANtastic, an entry-level, peer-to-peer LAN from ARTISOFT incorporates features of the industry's more-prominent networks. In addition to DOS 3.1 file and record locking and NETBIOS compatibility, LANtastic has audit trails, printer spooling, and E-mail, security, and CD-ROM support.

These are impressive features for a $495, 120-node LAN license. System integrators can purchase LANtastic with proprietary adapter cards or as a generic network operating system (NOS) for any LAN adapter that has a NETBIOS-compatible interface.

LANtastic was tested on a network of seven IBM PS/2 Model 50s with IBM's PC-Network broadband hardware sharing a Hewlett-Packard LaserJet+ printer and an IBM Model 70 (20 MHz) as a dedicated server.

The network is used 24 hours a day in a university setting. Applications include word processing (WordPerfect Corporation's WordPerfect), desktop publishing (Aldus's PageMaker), graphics (IBM's StoryBoard Plus and ZSoft's PC Paintbrush Plus), expert system development (EXSYS Inc.'s EXSYS), spreadsheets (Borland's Quattro and Lotus 1-2-3), data management (Ashton-Tate's dBASE III PLUS and Microrim's R:BASE for DOS), and languages (Borland's Turbo Prolog, BASIC, and C).

To install LANtastic, the first step is to copy the files from the distribution diskette onto the server or run the NET_MGR program on the distribution disk. For a server with redirector, the NET_MGR installation process first copies the executable programs from the distribution diskette into a subdirectory called \LANTASTI. This subdirectory can be anywhere on the server as long as it is in the server's PATH, but NET_MGR creates this subdirectory in the root directory.

The installation program also creates another subdirectory called \LANTASTI.NET. It contains each user's and each shared directory's access configuration in separate subdirectories, each containing a hidden file called LINKACL. This subdirectory should not be accessible by remote users. The installation process does not alter the CONFIG.SYS or AUTOEXEC.BAT files.

Once the software from the non-copy-protected distribution diskette is installed, NET_MGR sets up the server for its users. The installer simply selects the item User Account Information from the Main Functions menu and responds to the pop-up prompts. Each new user requires a unique user name, password, user description, and a maximum number of concurrent logins. Modifying a current user's account involves the same procedure.

Because LANtastic allows users to have concurrent logins, several users may log in under the same user name from different machines to access one user's network resources. An alternative is to group users by a common prefix to each user name. The administrator can assign the same resources to groups on the server.

The administrator specifies users' shared network resources by selecting "Network access information" from the main menu. NET_MGR guides the administrator through the process with

pop-up prompts. The process consists of first naming the device, drive, CD-ROM drive, or directory to be shared, and then modifying the shared-resource list to specify a description of the resource, link path, and who has what type of access to it. The link path is the server's true path.

Access to shared resources is controlled through an administrator-created access control list (ACL). If the administrator does not create an ACL, all users will have full access to every shared resource. LANtastic permits 11 types of access rights, from read-only access to full physical access. The administrator is able to specify access rights by user or by groups of users. Both printer and mail access are controlled in a similar way. The administrator can also assign server access, such as Super Queue Privileges, which permits a user to view and manipulate all jobs in the print queue.

NET_MGR also can configure the server's start-up parameters for a maximum number of users, network buffers, number of server network adapters, network tasks, and monitoring network activity. NET_MGR walks the administrator through the process with pop-up prompts.

Servers require the DOS SHARE program to be loaded, followed by LANtastic's REDIR program with the proper parameters to start the server as a redirector, and finally LANtastic's SERVER program to start the server. Nonserver stations must first load NETBIOS or local area network BIOS (LANBIOS) before LANtastic's REDIR program. Each computer requires a unique machine name as a parameter in the REDIR program. The names are required by NETBIOS. The installer also can specify redirector buffers as a parameter to the REDIR program. Once REDIR is loaded, redirectors can invoke NET LOGIN and NET USE commands to get the network running.

Workstation software consumes a total of 179KB of RAM, well below IBM's PC LAN program and about on par with some of the other DOS-based LAN programs.

LAN users generally have little or no patience with a network that goes down. LANtastic is reliable and is not prone to crashing. The network does have a small quirk, however; it will not log users back onto the network immediately after they reboot their systems. According to ARTISOFT's technical personnel, this is a NETBIOS time-out problem. The program fails to respond to the disconnect fast enough to recognize that the user is no longer on the network. The company, therefore, suggests allowing each user account two concurrent logins. As a result, when users log in after rebooting, LANtastic sees it as the second concurrent login and permits it.

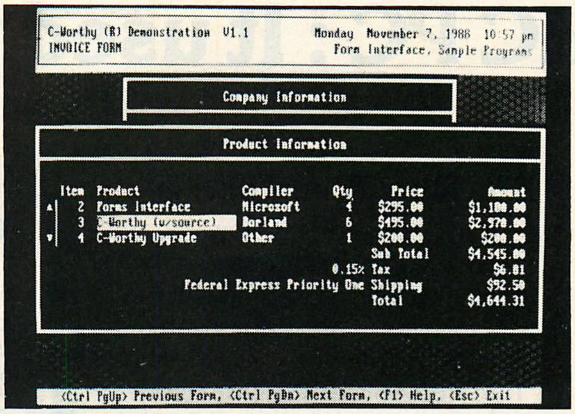
Another welcome feature of LANtastic often overlooked by LAN operating systems is the ability to monitor network activity. LANtastic permits the administrator to establish eight levels of audit trails; to track, for example, when users login, print, and logout. Saving the audit trail to a file provides an ASCII text record of user activity—a useful tool for an administrator trying to fine-tune a network for the most efficient operation.

Overall, LANtastic is a well-conceived and well-implemented networking system. Its low-memory overhead, powerful control capabilities, reliability, and security features provide the system administrator with the tools required to manage a viable network. The system's sophisticated and powerful security system for shared resources is particularly noteworthy.

—RALPH SHAFER

Developers of in-house and commercial "vertical" software...

Only C-Worthy® protects you from the trap that keeps 50% of the market from using your software . . .



A Perfect Input Screen? Focus the user on the **simple** and **probable** next step, and speed data entry by 10 to 30%. Resolve the ambiguous choice (e.g., "Other") by a hidden sub-menu.

...The Trap: Users will reject your application if the interface is too hard to use. They'll never even see the power of your program. *". . . If you've messed up the interface, the product is probably dead in the water."*
— Jeffrey Tarter, Editor, Soft●Letter

False Solution #1: Write your own interface. Spend a week learning the latest findings on human interfaces. Then spend 2-4 months creating the features users now demand: windows, menus, help screens, data validation routines, error handling, etc.

False Solution #2: Buy an incomplete C-tools library that does not specialize in the interface problem. Spend weeks before you learn it doesn't have the interface functions you need. *"We actually bought a number of C libraries to compare with each other. We choose C-Worthy because it offers everything we need...the user interface you create with it is slick and consistent...it's well written and portable...it's fast and professional."*
— David Pariseau, President, Lighthouse Associates

True Solution: Use the C-Worthy Interface Library **Risk-Free for 60 days.** See for yourself why it's the only choice for programmers who take interface problems seriously.

"C-Worthy is a higher level approach to human interface than other C libraries...Our software engineering department does not use another human interface library."
— Kevin Kingdom, Senior Software Engineer, Novell, Inc. (Over 500,000 users of Novell NetWare® Utilities use a C-Worthy-based interface every day!)

8 work-years are invested in C-Worthy interface solutions. Our investment means **you save time** on every programming project. If you were planning to spend 2 weeks creating a good interface for your next project, use C-Worthy and cut that time in half. And you can count on C-Worthy to produce an interface that pleases even the most demanding users...

C-Worthy gives you total control through 350 functions...**Windows, Screens, Menus** (see box at right). **Error handling:** DOS, program and user. **Help:** system and context-senstive. **Keyboard handling:** regular function, interrupt, background procedures. **Editing:** string and word-wrap text. **DOS interface:** file, dir and drive mgt., date and time conversion, wildcards, more. **Data input forms** (optional).

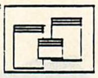
These 10 high-level functions give you control over — and make implicit use of — C-Worthy's 350 tightly integrated functions:

InitUtility[1,2]	AppendToList
PushList[1]	List
InitList[1]	EditString
AppendToPopUpMenu[1]	EditText[2]
PopUpMenu[1]	RestoreUtility

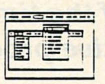
[1]The only functions you need for building a menu.
[2]The only functions you need to build a full-screen word-wrapping text editor.

Plus...**Compatible with MS Windows.** OS/2 version now shipping! Autodetect for MDA, CGA, EGA, VGA. **Foreign languages:** all text messages in separate files for easy translation. **C Compilers:** Microsoft, Quick, Turbo, Lattice. **No royalties.** System Requirements: 256K RAM, MS-DOS 2.0+ or OS/2, and IBM PC (or compatible), TI Professional, NEC APC III, or Victor 9000.

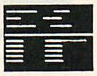
Functionally Superior to Competing Environments



Screens & Windows. Exploding, tiled or overlapping. Direct video access or virtual. Keep up to 50 active.



Menus. Pop-up, Lotus style, pull-up and pull-down (Windows-style.) Automatically sized to fit your choice of options, header border type. Auto-select based on key-menu-item character you select.



Forms. Optional Form Interface Library speeds construction of data input forms, lets you apply latest research findings to gather and validate input. 17 field types, built-in or custom validation. Provide help at form and field levels. User-overridable movement sequence within the form.

Comprehensive documentation. 1035 pages, fully indexed, plus 10,000 lines of ready-to-go-code that you can run, modify and learn from.

C-Worthy Interface Library

Object only	$195	Form Interface Library add on	$100
Object with Forms	$295	Object with Forms & Library Source	$495

Ask for 2 FREE Bonuses Just for Trying C-Worthy.

Call 800-821-2492 ext. 353

(in MA and outside U.S. 617-337-6963)

Bonus 1. *Designing the Human Interface: Strategies for Effective Human-Computer Interaction.* The leading reference on the subject, 448 pages, $29.95 from Addison-Wesley.

Bonus 2. *Guidelines for Designing User Interface Software.* Contains 944 guidelines, including graphic functions and data display. 496 pages, $38.95.

Solution Systems™
541 Main Street, Suite 410
South Weymouth, MA 02190
Fax: 617-337-7719

CIRCLE NO. 166 ON READER SERVICE CARD

MAGIC PC™: It used to be a secret...

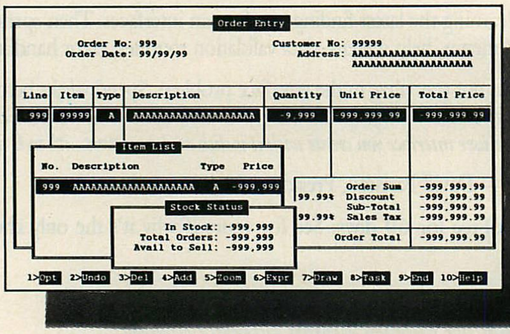
Not Anymore!

Thousands of top Professional and Corporate DBMS developers revealed to **PC WEEK**[1] the secret to their success: Magic PC – The Visual Database Language.

Surprised? We're not. We knew all along that database pro's, consultants and VARs guard Magic PC as a valuable trade secret. No wonder. It gives them a superior competitive edge: powerful applications 10-20 times faster than any DBMS or 4GL.

The Story Behind dBASE

More interesting is how the respondents placed a lesser-known package, Aker Corp.'s Magic PC, in the top grouping and relegated a very well-known package, Ashton-Tate's dBASE III Plus, to eighth place.

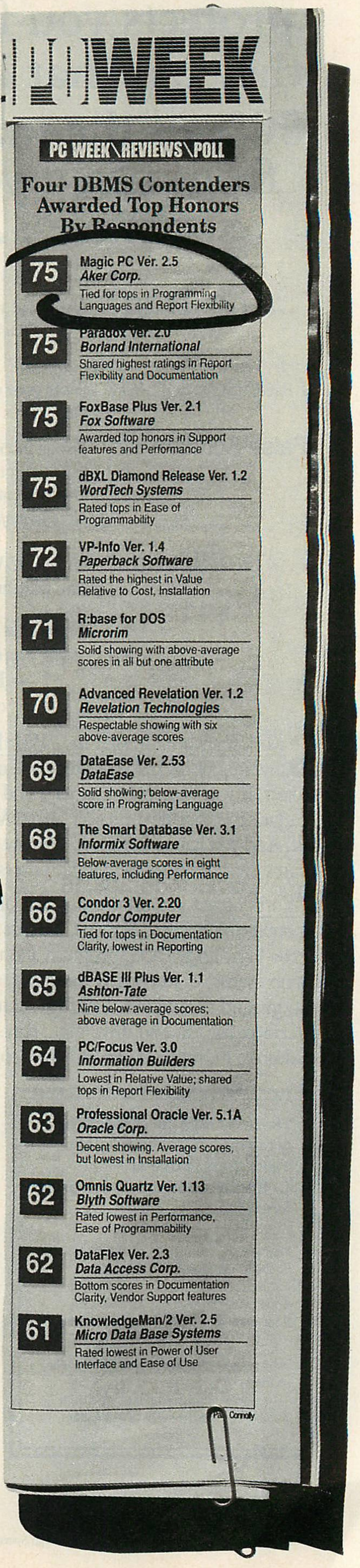


Goodbye 4GLs

Magic PC's revolutionary power and programming speed obsoletes conventional database languages, just like CAD obsoletes manual drafting. Magic PC frees you from the entire coding and maintenance responsibility, so you can concentrate on your system design.

You specify dictionaries, processing flow scheme and drawings of screens, reports, windows, menus, etc. Design changes are easily applied on the fly and automatically maintained. Your design is immediately executed by Magic PC's stand-alone runtime engine.

You finish even before conventional DBMS programmers normally begin the coding phase. Imagine saving all those months of tedious trial-and-error coding, debugging, testing and re-coding.



PC WEEK

PC WEEK\REVIEWS\POLL

Four DBMS Contenders Awarded Top Honors By Respondents

75 Magic PC Ver. 2.5 — *Aker Corp.* — Tied for tops in Programming Languages and Report Flexibility

75 Paradox Ver. 2.0 — *Borland International* — Shared highest ratings in Report Flexibility and Documentation

75 FoxBase Plus Ver. 2.1 — *Fox Software* — Awarded top honors in Support features and Performance

75 dBXL Diamond Release Ver. 1.2 — *WordTech Systems* — Rated tops in Ease of Programmability

72 VP-Info Ver. 1.4 — *Paperback Software* — Rated the highest in Value Relative to Cost, Installation

71 R:base for DOS — *Microrim* — Solid showing with above-average scores in all but one attribute

70 Advanced Revelation Ver. 1.2 — *Revelation Technologies* — Respectable showing with six above-average scores

69 DataEase Ver. 2.53 — *DataEase* — Solid showing; below-average score in Programing Language

68 The Smart Database Ver. 3.1 — *Informix Software* — Below-average scores in eight features, including Performance

66 Condor 3 Ver. 2.20 — *Condor Computer* — Tied for tops in Documentation Clarity, lowest in Reporting

65 dBASE III Plus Ver. 1.1 — *Ashton-Tate* — Nine below-average scores; above average in Documentation

64 PC/Focus Ver. 3.0 — *Information Builders* — Lowest in Relative Value; shared tops in Report Flexibility

63 Professional Oracle Ver. 5.1A — *Oracle Corp.* — Decent showing. Average scores, but lowest in Installation

62 Omnis Quartz Ver. 1.13 — *Blyth Software* — Rated lowest in Performance, Ease of Programmability

62 DataFlex Ver. 2.3 — *Data Access Corp.* — Bottom scores in Documentation Clarity, Vendor Support features

61 KnowledgeMan/2 Ver. 2.5 — *Micro Data Base Systems* — Rated lowest in Power of User Interface and Ease of Use

Pat Connolly

PC TECH Journal concurs:

"Magic PC's database engine delivers powerful applications in a fraction of the time... there is no competitive product."

State-of-the-art Features

Automatic non-procedural processing

Event-driven execution control

Multi-User RDBMS

Quick Prototyping

Multi-file zoom lookups

Easy-to-use user interface

Built-in visual query-by-example

Proven BTRIEVE® Performance

Magic PC is based on Novell's Btrieve® for maximum performance and reliability. And if you already program with Btrieve®, use Magic PC to create instant customizations of your existing applications with full file compatibility, beyond Xtrieve® and Rtrieve®.

30 Day Money Back Guarantee

Discover the secret to professional DBMS success. Order your copy of Magic PC now without any risk! Magic PC single user $299, Magic LAN multi-user $699[2]. But, if you'd rather spend your time coding — simply return in 30 days and we'll refund you promptly less $19.95 restocking, no questions asked.

Dealers Welcome

800-345-6244

In CA 714-250-1718

Fax: 714-955-0199

AKER

19782 MacArthur Bl. Suite 305, Irvine, CA 92715

1 PC WEEK, Jan. 16 '89

2 Add $10 P&H, tax in CA. Requires IBM/100% comp., 512K hard disk, DOS 3.1 or later. Includes Btrieve runtime. 5.25" not copy protected. Btrieve®, Xtrieve®, Rtrieve® are tradenames of Novell.

TECH NOTEBOOK

A forum for sharing solutions to technical problems

TED MIRECKI

1 DOS 4.0 AND EMS

2 DOS 4.0 SHELL

Each new version of DOS introduces not only welcome new features, but also a host of quirks, anomalies, and outright bugs. Such is the case with DOS 4.0 and its update, version 4.01. This month, we consider problems with two of the major innovations in these DOS versions (collectively referred to as DOS 4.0*x*): the use of expanded memory and the DOS 4.0 Shell interface.

The first item describes major anomalies in the way DOS 4.0*x* uses expanded memory (EMS) when interacting with a non-IBM expanded-memory manager (EMM). Most of this information was submitted by Bob Smith of Qualitas Inc. (Bethesda, Maryland), with Gary Pope of Quarterdeck Office Systems (Santa Monica, California) providing additional insight.

The second item provides information about how DOS 4.0*x* interacts with its user shell, supplementing the scanty documentation that IBM and Microsoft provide for it.

1 EMS PROBLEMS IN DOS 4.0*x*

DOS 4.0*x* supports EMS in two ways. First, DOS includes device drivers (XMA2EMS.SYS and XMAEM.SYS) that provide EMM for IBM memory-expansion boards and 386 systems. XMA2EMS.SYS is an EMM for IBM memory-expansion boards, equivalent to Intel's EMM.SYS for the Above Board or AST's REMM.SYS for RAMpage boards. XMAEM.SYS provides EMS memory on 386 systems by activating the paging mechanism of that CPU. When XMAEM.SYS is used in conjunction with XMA2EMS.SYS, it is the equivalent of 386-to-the-Max from Qualitas or QEMM-386 from Quarterdeck.

Second, DOS 4.0*x* can use expanded memory for a RAM disk and for caching disk information. The inclusion of EMM drivers with DOS and the use of EMS memory by DOS are two separate issues. Installing the IBM EMM drivers does not automatically cause DOS to use expanded memory, and DOS can use expanded memory with a non-IBM EMM. This item considers only how DOS uses EMS, especially in conjunction with non-IBM EMMs.

DOS 4.0*x* supports the use of expanded memory in three instances: VDISK, BUFFERS, and FASTOPEN. In each case, the user enables the use of EMS by specifying the /X switch on the command line that activates the feature. VDISK establishes a RAM disk in expanded memory, while the BUFFERS and FASTOPEN commands establish disk-cache buffers. In the case of BUFFERS and FASTOPEN, the DOS interface to EMS suffers from poor design and bugs that, at best, can crash the system and, at worst, damage the data on a hard disk. This is true of both the initial release of IBM's DOS 4.0 with files dated 06-17-88 and the version 4.01 update dated 08-03-88. Microsoft's latest version of MS-DOS, however, labeled 4.0 and dated 10-06-88, does not exhibit the anomalies described here. (*PC Tech Journal* examined a not-for-distribution copy that was not branded by any vendor.)

When either the BUFFERS or the FASTOPEN statement specifies the /X switch, DOS reserves for itself the two highest-numbered page frames outside of the primary frames. Note that besides reserving pages of expanded memory (as does any well-behaved program that uses EMS), DOS claims exclusive use of *page frames* at specific addresses in the physical address space. No provision is made for this in the Expanded Memory Specification.

Furthermore, DOS hides these frames from all other processes. Because DOS assumes that no other process can access its frames, it does not bother to save and restore their contents. This assumption fails if a multitasking system (such as Quarterdeck's DESQview) changes the mapping by switching to an alternate register set.

Consider the case where DOS caches a file allocation table (FAT) or directory in a buffer in one of its private page frames, then writes that buffer out to disk without ensuring that the appropriate EMS page is still mapped to the frame. If the operating environment has switched the mapping context in the meantime, the FAT or directory gets overwritten with garbage, and some or all of the data on the disk goes into the bit bucket.

A more likely, but fortunately less damaging failure occurs if DOS reserves page frames within conventional memory. Because DOS takes the highest-numbered pages, and the EMM assigns higher numbers to frames at higher addresses, these pages are invariably at the top of conventional memory, where DOS keeps the transient portion of COMMAND.COM. Using the same area for buffers, however, overwrites COMMAND.COM. This might not seem to be a major problem, because the low-memory portion of DOS checks the upper portion and reloads COMMAND.COM if it gets trashed; however, the check is performed only when COMMAND.COM resumes control after executing a process.

While DOS is in control, it assumes that its upper reaches are intact. So, two portions of DOS are operating under two conflicting assumptions. First, the disk-caching process assumes that its page frames are not accessible to any other process, so it neglects to save and restore the original contents. Second, the kernel assumes that while it is in control, nothing can happen to upper memory; so, upon completion of disk activity, it branches to the command processor without checking its integrity. The result is that the system hangs during boot-up, right after COMMAND.COM is initially loaded.

DOS will not use frames in conventional memory if frames with higher numbers exist above the video buffers. Beyond requiring that the primary page frames be numbered 0 through 3, the EMS documentation does not specify the sequence of numbering page frames. Most EMM drivers assign numbers to the frames above conventional memory before numbering the ones below 640KB; as a result, the highest-numbered frame is in the top-most 16KB of conventional memory. The IBM drivers and 386-to-the-Max implement a different numbering sequence: after the primary frames, they number frames in conventional memory, then any remaining ones above. To provide compatibility with DOS 4.0, current versions of Quarterdeck's EMM drivers (QEMM-386 4.23 for 386 systems and QEMM-50/60 4.03 for the IBM PS/2 80286 memory-expansion board) accept the /DOS4 switch that imposes the required numbering sequence.

With either 386-to-the-Max or the /DOS4 switch on Quarterdeck's drivers, BUFFERS /X and FASTOPEN /X will install without crashing, as long as there are at least six page frames (two more than are required for the primary frame) above conventional memory. By default, Quarterdeck's drivers create page frames in each unoccupied 16KB block of upper memory, but 386-to-the-Max creates only the four primary frames unless additional ones are requested by the INCLUDE command-line parameter. For example, INCLUDE=32 allocates two additional 16KB page frames in any available location, while INCLUDE=C000-CC00 allocates three contiguous frames beginning at segment C000H.

There are two additional problems when FASTOPEN /X is used with a non-IBM EMM driver. The first problem, which causes it to crash during installation, can be fixed by patching the code with a debugger. Even with the patch, however, FASTOPEN refuses to recognize expanded memory if more than seven page frames are present. It inexplicably returns the error message, "Expanded memory not available." The only solution to this is to eliminate page frames in conventional memory by specifying the parameter EXCLUDE=1000-A000. This, however, practically shuts down multitasking in environments such as Microsoft Windows, Quarterdeck's DESQview, or OMNIVIEW from Sunny Hill Software (Seattle, Washington). The loss of multitasking offsets any advantages of FASTOPEN, so the best solution is either not to use FASTOPEN at all or to use it without the /X switch.

If you do not run a multitasking environment and insist on having FASTOPEN use EMS, here is how to patch it. Copy FASTOPEN.EXE to a file with some other extension; then, load it with DEBUG and unassemble at address 2C65:

```
xxxx:2C65  MOV   AX,5800
xxxx:2C68  INT   67
xxxx:2C6A  CMP   AH,00
xxxx:2C6D  JNZ   2C9D
xxxx:2C6F  MOV   [01C7],CX
xxxx:2C73  MOV   AX,0004
xxxx:2C76  MUL   CX
xxxx:2C78  CMP   AX,001E
xxxx:2C7B  JG    2C9D
xxxx:2C7D  MOV   AX,5800
xxxx:2C80  PUSH  DS
xxxx:2C81  POP   ES
xxxx:2C82  LEA   DI,[01C9]
xxxx:2C86  INT   67
```

This sequence is supposed to obtain an array of page-frame addresses. The first INT 67H call should request the size of the array, the second one should read the array into ES:1C9. The first call, however, mistakenly loads function 5800H (get array) instead of 5801H (get number of entries in array). As it happens, both functions return the count in CX, so the first INT 67H does what is intended, but as an unintended side-effect, writes the array into wherever ES:DI happens to be pointing. Evidently, with IBM's EMM, nothing critical gets overwritten, but with 386-to-the-Max, the system crashes.

The solution is to assemble the following instruction at address 2C65: MOV AX,5801. After writing the file to disk, copy it into FASTOPEN.EXE.

2 CUSTOMIZING THE DOS SHELL

Although expert users typically eschew DOS shells, they often need to install and maintain them for less expert users. The shell provided with DOS 4.0 is far from the best example of the genre, but it is part of DOS, so we had better become familiar with it. IBM and Microsoft provide little information on its implementation and configuration. The installation process creates a batch file that invokes the shell, but there is no explanation of the contents of the file and little about customizing it.

The shell consists of three components: the programs SHELLB.COM and SHELLC.EXE, and the batch file

DOSSHELL.BAT. The first is a terminate-and-stay-resident (TSR) program that installs an INT 2F handler; the second is the shell program proper. The user invokes the shell by executing the batch file; it runs SHELLB.COM and, if that program does not return an error, executes SHELLC.EXE. SHELLB must run at every invocation of the shell, although it installs itself only the first time it is executed. On subsequent executions, it merely reinitializes the already-installed INT 2F handler.

The resident portion of SHELLB occupies 3,712 bytes. On a 386 system with an EMM, such as 386-to-the-Max or QEMM-386, you can get it out of DOS memory by loading it into high memory, above the video buffers. In the AUTOEXEC.BAT file, install SHELLB using the load-high option of the memory manager. On the first invocation of DOSSHELL.BAT, SHELLB finds itself already installed and reinitializes itself in high memory.

Whether SHELLB is invoked from DOSSHELL.BAT or AUTOEXEC.BAT, it needs to have a command-line parameter. The installation process creates this parameter as DOSSHELL, the name of the batch file that invokes SHELLB and SHELLC. SHELLB, however, checks only for the presence of a parameter (and fails with an error message if there is none), but does nothing with it. Any string, whether or not it specifies an existing file, is equally acceptable.

The installation program creates the command that invokes the main program, SHELLC, with many parameters for controlling its operation. These parameters are documented in chapter 5 of *Getting Started with DOS,* but the manual does not clearly state the available options.

The /MENU parameter enables the start-program screen, while the /DOS parameter enables the file manager. If /MENU is present on the SHELLC command line, the shell initially displays the program starter. If /DOS is present, but /MENU is not, the shell immediately enters the file manager. If neither one is present, the shell aborts with an error message.

If you like the shell's file manager, but prefer to execute programs from the command line rather than from a menu, you can have DOSSHELL directly start the file manager by removing the /MENU parameter from the SHELLC command line. Replace it with %1, so you can get the program starter (you need it to change screen colors, for example) by typing DOSSHELL /MENU.

The /CLR and /MEU parameters specify the names of files that determine the screen colors and the programs that appear on the menus, respectively. These two parameters are optional, and if they are omitted, the file names default to SHELL.CLR and SHELL.MEU. If the filename parameters are omitted, SHELLC looks for the default files in the directories specified by APPEND, not PATH.

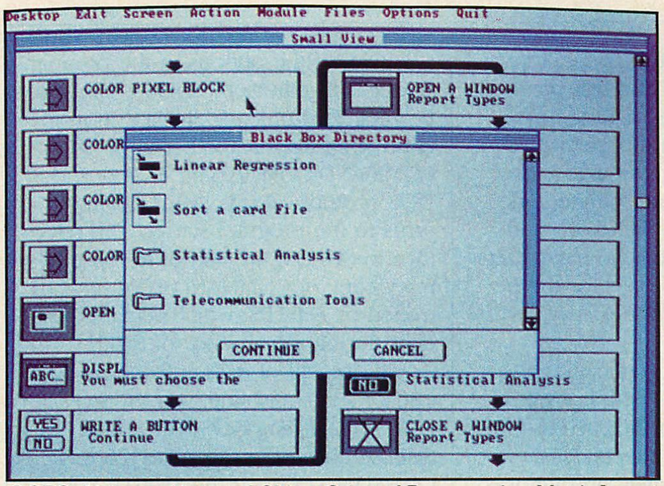
The /MOS parameter names a mouse driver for the shell; however, the driver must be in the current directory. SHELLB uses neither APPEND nor PATH to locate the driver, and ignores any explicit path specified in the /MOS parameter. If the named driver is not in the current directory, however, the mouse will not operate in the shell.

This is no great loss, because SHELLC does not need its own mouse driver. If there is no /MOS parameter, SHELLC uses the resident system-level mouse driver installed through the CONFIG.SYS or AUTOEXEC.BAT files. Any system with a mouse will already have a resident driver, so there is no point taking up more memory for another driver just for use by the shell. Simply remove the /MOS parameter from the line that invokes SHELLC.

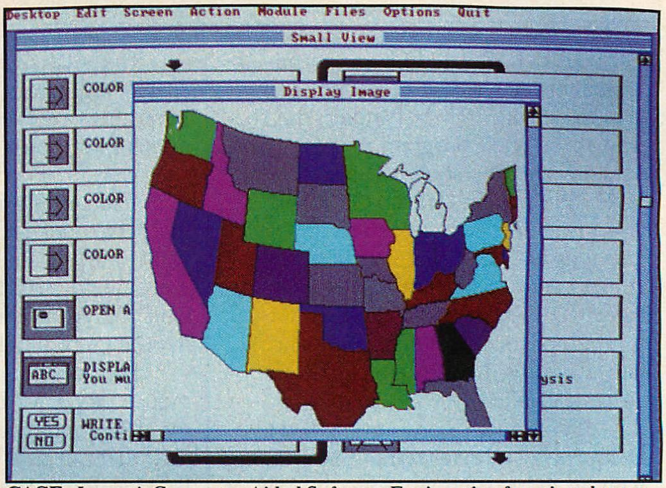
One of the options in the program starter is to exit to the DOS command prompt. This unloads SHELLC in its entirety and loads another copy of COMMAND.COM. Typing EXIT at the DOS prompt reloads SHELLC and returns to the program starter. The return to SHELLC, instead of to the primary copy of COMMAND.COM, is controlled by SHELLB, which remains resident during the absence of SHELLC.

If, instead of exiting from the secondary command line, you invoke DOSSHELL again, DOS will reload SHELLC above the secondary copy of COMMAND.COM. If the SHELLC command line, however, omits the /MENU parameter (in order to start the file manager directly), the screen goes blank. The system does not crash, and you can exit to DOS by pressing the F3 key, the normal exit from the file manager. The display will have no problem if the second invocation of SHELLC invokes the program starter.

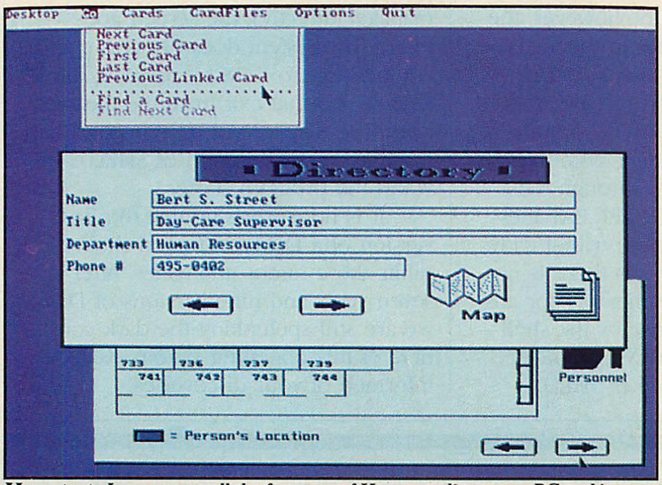
It is not surprising that the first version of a DOS-sanctioned shell exhibits these minor anomalies. After seven years and nine versions of DOS, we are still spelunking the dark corners of this operating system. Keep us informed of your discoveries.



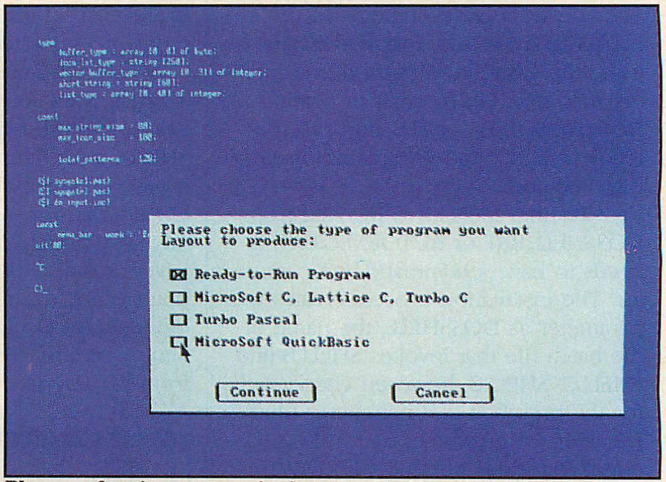
OOPS. *Using sophisticated Object-Oriented Programming, Matrix Layout gives you the power to build complete applications faster than you thought possible. And that's just the beginning.*



CASE. *Layout's Computer Aided Software Engineering functions let you design programs using an intuitive flowchart model. Then, Layout can automatically turn your flowchart into source code or even an .EXE file.*



Hypertext. *Layout puts all the features of Hypercard® on your PC and in your programs. Use Layout's graphical user interface to create documents with action links to related documents in any file. Or to create hyperlink applications.*



Plus, your favorite programming language(s). *Using Layout's tools, you can cut your coding time up to 70 percent, and still produce ready-to-run programs in your choice of languages.*

A Great Programming Tool Should Contain All Of The Above.

Presenting Matrix Layout, the first full software development system for the PC to promise you all the above. And deliver.

Sit down to Layout's intuitive user interface and in minutes you'll be using advanced OOPS (Object-Oriented Programming System) and CASE technology to build your program. Simply draw a flowchart indicating the windows, buttons, menus, text, and graphics you want.

A Cut Above Other Tools.

Layout also provides flowchart elements for Hypertext data base capabilities, math functions, variable management, conditional branching and looping. And, its open architecture allows you to build your own Black Box elements — to create exactly the program you want.

When your flowchart is ready, Layout uses artificial intelligence technology to automatically turn it into code — Turbo Pascal, Turbo C, Microsoft C, QuickBasic or Lattice C. Or create a ready-to-run .EXE file right from within Layout.

It's so efficient, your programs will run incredibly fast, even on a standard 256K PC. Plus, they'll include Layout's automatic mouse support and device independence.

All The Above And More.

- *Matrix Helpmaker* helps you create context-sensitive help and complete on-line documentation for your programs.
- *Matrix Paint* offers a full set of graphics tools, scanner support, and clip-art files to make your programs look professional.
- Finally, *Matrix Desktop* gives you a simple, visual way to organize files and disks.

For A Lot Below.

Layout delivers all the above for just $149.95 — a lot below what you'd expect. Especially when you throw in free customer support, no copy protection, and a 30-day, money-back guarantee.

Video Tape Offer. Still not convinced? Call for a copy of our Matrix Layout VHS demonstration video at 1-800-533-5644 (just $9.95 for shipping and handling, credited against your purchase). In Massachusetts, call (617) 567-0037.

Any way you look at it, Matrix Layout is the ultimate PC programmer's tool. And that's the bottom line.

MATRIX LAYOUT

Matrix Software Technology Corporation • One Massachussetts Technology Center • Harborside Drive • Boston, MA 02128 • (617) 567-0037

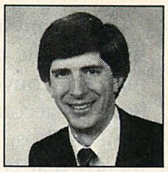
Matrix Software/UK • Plymouth, England • 0752-796-363 • Matrix Software/Belgium • Geldenaaksebaan 476 • 3030 Leuven • 016202064

TJ 894

CIRCLE NO. 123 ON READER SERVICE CARD

OUTFITTING THE END USER

Sorry, You're Not My Type



P.C. Coffee

Abstract data types encourage open-minded analysis of the problem, before a solution develops a life of its own.

How many times have you seen the intended users of a new system react with baffled dismay: "What good is it if it can't do [insert some critical function here]?" Why are the intended users frequently surprised by what's missing from a system upon its initial delivery?

At best, this reaction will cause lost time or reduced productivity—either of which is quite bad enough. Perhaps more dangerous still, however, are the occasions when users think they have discovered a way to provide a desired function that was missing from the original design.

Consider the case of Warehouse 14: the fictitious warehouse created by users of the material-tracking system for a major metropolitan transit authority. The users of that system found that it offered no direct method to record loss, theft, or other unplanned transfers of parts or supplies; they responded by inventing an additional warehouse, existing only in the world of their computer's tracking system, to which such items could be sent.

This got the discrepancy off the books of the person with the immediate problem, and everything was fine until Warehouse 14 started to build up a significant (though completely fictitious) inventory. Users who didn't know the scoop started to complain that Warehouse 14 never responded to their requests. "Warehouse which?" asked the startled administrator. Consequences followed.

The moral of the story? Never forget that users are human beings, members of the species that calls the shots in a world full of beasts that are faster, tougher, and meaner. The human race got to this position by being smarter and more adaptable than all the others.

In the world of systems development and integration, the impact of this ecological fact is that users will find ways to get around your petty little roadblocks, even the ones you create by accident. You probably won't like the side effects.

A critical goal in systems design, therefore, is to keep the need for such misguided user ingenuity to an absolute minimum. Abstract data types are powerful tools toward this end.

DATA: BITS ANONYMOUS

In many systems, data sit around like unlabeled bottles in a medicine chest. Pass a floating-point value to a print subroutine that expects an integer—the result makes an allergic reaction to penicillin look like a simple case of hiccups by comparison.

The reason is that many of today's tools operate on a model of "You asked for it, you got it." This is not because the designers of programming languages like the idea of leaving sharp edges exposed so programmers can hurt themselves; rather, it is purely a matter of self-defense. If there is any possible reason for doing something, the programming community howls with outrage if a tool prevents them from doing it at will.

This is fine, so long as programmers can reasonably be expected to avoid becoming the victims of their own injudicious cleverness. In a market dominated by the demand for ever-greater performance, such restraint often falls by the wayside. The pressure to be clever is powerful indeed, and it can be a terribly seductive trap.

As Kernighan and Plauger note in *The Elements of Programming Style* (McGraw Hill, 1978), "Everyone knows that debugging is twice as hard as writing a program in the first place. So if you're as clever as you can be when you write it, how will you ever debug it?" It is a long tradition of undisciplined cleverness that has given the C programming language its nickname of "write-only code." Abstract data types provide a mechanism for programmers to make their intentions clearer to themselves, as well as to the compiler.

This is not to suggest that programmers have the attention span of a two-year old, or that they suffer from tunnel vision with the breadth of a laser beam. (Examples of both can be found, of course, but they are far from typical.) Programmers can usually be expected, for example, to recognize the distinction between integers and floats.

More subtle issues face developers, however, that no amount of intelligence will resolve. Some decisions require actual knowledge—a different thing altogether.

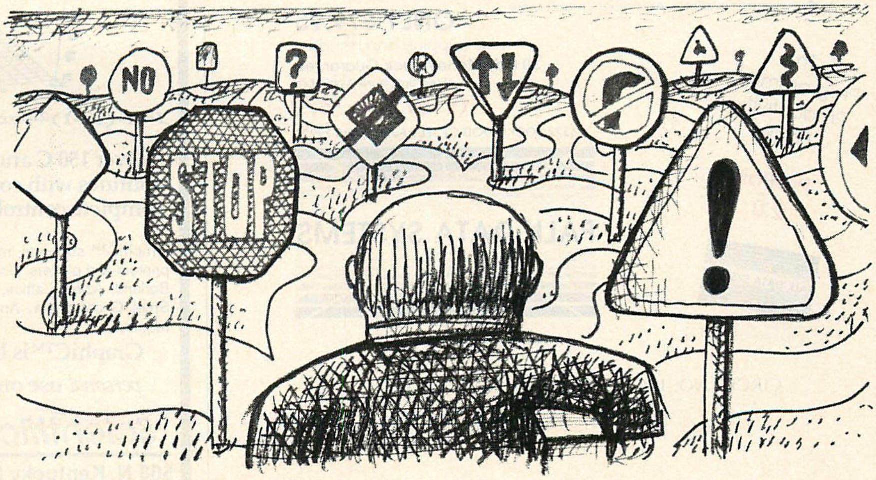


ILLUSTRATION • MACIEK ALBRECHT

In many industries, for example, a high volume of government contracts makes it convenient for the company to keep its accounting books on the same basis as those of the federal government—that is, using a fiscal year that runs from October through the following September. Under these conditions, what is the meaning of the phrase, Year to Date? When is the Second Quarter? Are such terms to be interpreted for the fiscal year unless otherwise specified, or should the calendar year be the default?

Some programmers may dismiss such issues as merely a matter of requiring the user to write a decent specification. "Quality software is software that implements the specification exactly," concluded one participant in an on-line discussion last autumn. The irony was intentional, and emphasized that users have only themselves to blame if what they asked for is not what they really wanted.

One need not imagine a confused user, however, to come up with a scenario in which disaster arises from ignorance of the true nature of data. Consider the simple notion of equality between two variables. A variable might be physically implemented as a pointer to another location in memory, where the value of interest to the application (often a complex structure such as a record) is actually stored.

If a second variable is now made equal to the first, using a simple-minded notion of assignment, the result will be two identical pointers; a change in the contents of that remote data structure will now change the meaningful values of both variables at once, since both pointers correspond to a single underlying record. This Siamese-twin behavior is probably not what the programmer intended, but the problem may not show up at all in routine testing.

Avoiding this error requires global knowledge of the details of implementation, as well as an understanding of the data's intended meaning. This places programmers in a condition of information overload, particularly in the construction of large systems. "Building a cathedral out of matchsticks" is the phrase that has been used by some to describe this condition.

Abstract data types provide a built-in discipline that guards against this problem. The implementor of the pointer-based data type in this example would have had the power to define assignment of such values in terms of copying the target of the pointer, as well as copying the pointer itself. The decision, once made, would have been invisible to any future user of that data type who did not need to know the implementation details.

ABSTRACT, NOT OBSCURE

I note with foreboding that Sprint's on-line thesaurus says that *abstract* often means *obscure*; that's the last thing that I want you to be thinking. Let's focus on another synonym, *ideal*, and explore the bundle of things that should ideally derive from this concept.

An abstract data type is defined by a set of possible values and a list of the operations that are allowed upon those values, with a description of result that each operation should return. This sounds feeble, perhaps, but it's a powerful mechanism for the avoidance of gross error.

I'm reminded, for example, of the late Richard Feynman's story about the time he was asked to review a textbook proposed for use in the California public schools. The textbook, a math book, was trying to establish the idea that mathematics has applications throughout the sciences. The authors intro-

duced as an example, from astronomy, the relationship between color and temperature in the stars.

A word problem gave a table of colors versus temperatures, then described the colors of the stars that a boy and his father see in the sky one night. So far, so good. Then the book asked the question, "What is the total temperature of the stars that they see?" (Feynman describes his apoplectic fury caused by that question.) The notion of total temperature is meaningless, of course; temperature values can be added, but only as an intermediate step in calculating some descriptive statistic, such as their average.

The key point is that the performance of that intermediate addition, and its temporary result, should be hidden within the abstraction. On a stand-alone basis, *sum* is not a meaningful operation for data of type *temperature*; the user should not be able to request such an operation, nor even to see its value if it happens in the background.

An abstract type definition of temperature would require that the author address the basic issues like this one right up front. This sounds like an irritating constraint, and it is one of the things that some people dislike about languages (such as Ada) that require rigorous type definition.

In return, however, this constraint provides important benefits during the design phase. When you have to think about what is legitimate to do with a value, it serves as a catalyst for imagining all the things that it might be useful to do.

In the long run, this can only help the user; reasonable features will likely be considered during the earliest phases of the project, and those that are easily provided will probably make it into the design.

To return to our Warehouse 14 example, an abstract type definition of a warehouse-stored item would have necessarily led at some point to the question, "What can you do with a widget?" You can buy it, you can ship it, you can install it . . . hmmm; you can also lose it or steal it. So, allow an option in the design for missing, forestalling another potential crisis.

WHAT IF YOU CATCH THE CAR?

Abstract data types help the system designer focus on the uses of data, rather than the mere achievement of gathering the data—which brings to mind what the cat asked the dog: "What will you do with that car if you actually catch it?" This helps us avoid what Eugene Bedell has called the error of "amassing mountains of data in the hope that inspiration will follow."

One reads, for example, of new multimedia database products that allow the storage of images and sounds as well as conventional data, such as numbers and text. All very well, but what is the user supposed to do with the stored data?

How shall we implement searching on image fields, for example? Is it useful to be able to search for all bit maps that are at least 10-percent red? Maybe in some applications, though none come to mind.

More practically, a real-estate agent might like to search a database of images for all homes with bay windows facing the street. A journalist might like to find all photographs in which former President Reagan and General Secretary Gorbachev appear together. A law-enforcement official might like to search a sound record for all occurrences of the word "deal."

Such capabilities are far beyond the state of the art, and are likely to remain so for at least another decade.

In practice, then, how do people use their new image- and sound-data types? They put them into record structures that provide for user-specified key words, which are subject to conventional search techniques.

There are major problems, however, with schemes that require the user to associate ideas—that is, key words—with complex data as part of the process of initial data capture. Today's information systems generate such huge flows of raw data that it is hopeless to require even brief skimming by any kind of qualified observer.

Even if prescreening were possible, such a requirement overlooks a more subtle problem. That problem is the tendency of even the most honest and accurate data to say different things in response to different questions.

FOR THE BIRDS

I recall one recent example of a NASA team that was trying to identify mid-ocean landmarks. These were to be used by space shuttle pilots to make an emergency landing if their usual navigation aids were inoperative.

Their maps showed an island in a useful position, but said nothing about its suitability as a visual point of reference. The last known expedition to the island took place long before people accepted the idea of flying across oceans, let alone in earth orbit.

To their great surprise, however, a chance recollection by a librarian directed them to a written account of a naturalist's visit to the island to observe its distinctive birds. This account turned out to have a large amount of relevant information, but you had to be looking before you would notice these indirect facts.

For example, the account told of the difficulty of getting onto the island due to the sheer cliffs around its entire circumference. Relevant fact: the apparent size of the island would change very little between high and low tide.

Similarly, the records mentioned thick deposits of bird droppings on the rock covering much of the island. Relevant fact: the island would be clearly visible, a bright spot of white during daylight hours and in moonlight.

Other, more subtle pieces of information also emerged. The point, however, is that none of these characteristics would likely appear in a key-word summary generated by an archive clerk of over a century ago.

It is vital, therefore, to consider users' options for searching data when you are defining the types and attributes of the data to be used by a system that you are building. One cannot hope to predict the actual questions that users will want to ask, but one can at least try to devote as much attention to smart search facilities as to user-friendly input screens.

REFERENCES ON REQUEST

An interesting example of the need for such balance is the evolving definition of search facilities in word processors. We used to be happy if we could ask the system to find a substring. Then, we started to ask for distinction between embedded strings and whole words, followed in short order by the full-blown glory of regular expressions (such as "the letter p, followed by a one, two, or three, and then a zero"). So far, we were still working with the simplest attributes of text: what characters were present, and how they were arranged. For years, though, we have been moving rapidly into the next level

of text complexity—the multifont, multistyle world of page-layout applications driving Adobe's PostScript and other elaborate graphics engines.

Only recently have we seen word processors with the corresponding ability to search by font and by attribute; for example, to change all sans-serif text to monospace and change all underlined text to italic. The absence of these formatting features has generated untold hours of unnecessary work for users, and it seems to me that this imbalance would not have appeared if developers had been thinking of text as an abstract data type.

An abstract type view of text would automatically suggest that defining a new attribute, such as text style, should make that attribute a possible target for search and replacement. Abstract data types inherently encourage the designer to think about what Adele Goldberg calls "a semantically complete set of functions—a delete for every creation; a search for every specification.

BACK AT THE RANCH

To make an idea really take hold among systems developers, it obviously has to offer major benefits to them as well as to their systems' users. The attractive thing about abstract data types is that they greatly reduce the difficulties of program maintenance, and offer significant advantages in the potential for code reuse.

One sees this most clearly in the Ada language's concept of packages. A package can define data types, can define functions and procedures that operate on those types, and can define variables and constants that relate to those functions and procedures.

The syntax of Ada allows another program to incorporate such a package in whole or in part; for example, a program can say **WITH my_pkg;** to make a package's facilities visible, but must still make explicit reference to the package name in a function call such as **my_pkg.my_func(argument)**.

If the program instead says **WITH my_pkg; USE my_pkg;**, then the package need not be named again. The trade-off between convenience and clarity is left to the programmer. Many other things can be done by nesting packages, for example, that are well beyond the scope of this discussion.

Five years ago, my fledgling company, SolveWare, made its start with an extension to the IBM Macro Assembler that added support for the 8087 math coprocessor. We at SolveWare did it, in our opinion, right—that is, with strong data typing. This allows you to use the same instruction name to perform a given operation on any data type, rather than having six different mnemonics for each operation. It made the system slower, of course, but we figured that it was better to spend machine time than programmer time.

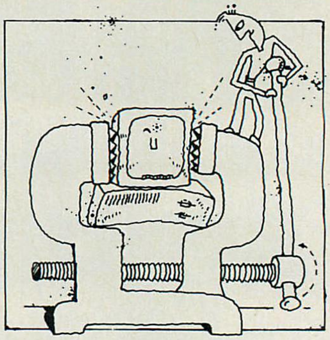
Perhaps we were just ahead of our time. Reviewers praised the ease of use exhibited, but panned the resulting lack of speed. As systems become faster, however, people seem more willing to let the machine handle more of the details. The idea of letting the compiler match the argument to the prototype of the function is gaining ground—for example, even in the performance-oriented C community.

For user and programmer alike, abstract data types help you tell everyone and everything exactly what you have in mind. Consider them as tools in your next system design.

Peter C. Coffee is managing partner of SolveWare, a developer and business computing consultant, and is active in AI and distributed computing applications for aerospace and educational clients.

JORDENE ZEIMETZ

PROFESSIONAL VIEWPOINT



PC Tech Journal readers are a tenacious group in avoiding bugs and super sleuths when tracking them.

To prevent errors from invading software applications, to hone in on insidious bugs, and to annihilate them, respondents to a recent reader opinion poll share several tried-and-true strategies.

Respondents offer no magic solutions for avoiding and detecting software bugs, but they strongly recommend a number of proven techniques.

At the top of the list are careful program design, structured testing of each module, and special diagnostic routines and messages.

ELUDING THE BUGS

Advocating a best-defense-is-a-good-offense approach is Tom Dettloff, a principal with Accounting Systems Development in Silver Spring, Maryland. He says, "careful planning, prototyping, and extensive testing avoid most bugs."

Dan Cox, president of the Virginia Computer Institute in Newport News, programs in a modular methodology, whether it is in BASIC, FORTRAN, COBOL, dBASE III PLUS, or Lotus macros. "This isolates any problems in a small area," he says.

Code walk-through by another programmer is the procedure behind the bug-avoidance efforts of Mike Smith, senior staff member of Advanced Technology Inc., in Reston, Virginia. He believes that "nothing beats a second pair of eyes."

William Jaffee, senior project leader for CompData Services in Washington, D.C., uses "test scripts built to test each pathway in the system, and puts them into macro-based program languages (Alpha Software Corporation's Keyworks Advanced). Then, with each change, we test the impact of the change on the full system."

Where boundary conditions are a factor, Miles Levy, research section head for UNISYS in Great Neck, New York, "tests for the seven conditions A − 1, A, A + 1, X, B − 1, B, B + 1 where A is less than or equal to N, which is less than or equal to B, and X is some middle value."

Because many software bugs are related to how programs are used, Roland Pearson, owner of CompuCraft in Herndon, Virginia, asks one expert and one novice end user to try the program. "Odds are one or both of them will find a way to break it that you never anticipated," he says.

THE STING OPERATION

When a bug is discovered, finding its cause can be the biggest dilemma.

Elliott Bay Computing Inc.'s (Seattle, Washington) president, Tim Winston, says the pervasive cause of C program bugs is invalid and misused pointers. "A special set of storage-allocation routines allows us to maintain the integrity of allocated storage. Coding standards for 'safe' pointer usage reduce the number of bugs in new code," he says.

Brian O'Connell, an engineering electronics technician at the U.S. Marine Corps' Camp Pendleton in California, has written a [Borland International] Turbo Pascal UNIT that monitors pointers, registers, and other variables and updates a CRASH.DTA file. "The user downloads the file to me—which tells the status of the program and machine," he says.

What special debugging and testing have you found work best for you?

After trying almost everything, Allan Abrahamse, a mathematician with the Santa Monica, California-based RAND Corporation, now uses two monitors. "I write debugging information to one and watch the program on the other. Blaise Computing's C Tools Plus makes this easy," he says.

For communications programs, Philip Tympanick, senior software engineer for McCormack & Dodge in Natick, Massachusetts, "adds code to the communications driver to capture data at the source to a disk file. A switch tells the driver to get its data from the file rather than from the remote device."

Michael Kulp, a software engineer in Atlanta, Georgia, relies on diagnostic messages planted in code. "I use a preprocessed test ('if' in C) to determine if the debugging for a module or function is enabled."

Similarly, Lee Woodworth in Lafayette, Colorado, firmly believes in writing "routines for complicated data structures that output the values in an easy-to-read form."

Once you find bugs, "externally document bug fixes. If something similar occurs in a different program, a history of similar fixes exists," recommends Daniel Clamage, a database programmer with Stellar Computer in Newton, Massachusetts.

THE BIG FIX

Success at avoiding, finding, and eradicating bugs in applications depends on how practiced a sleuth you are. While hardware and software debuggers play a decisive part in ousting software bugs, respondents believe the best weapon is a developer who is persistent and resourceful.

INDEX TO ADVERTISERS

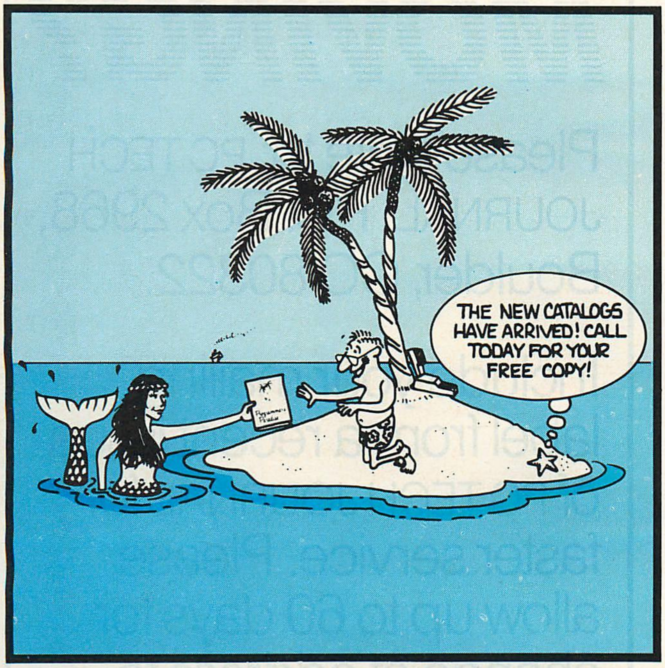
INDEX TO PRODUCTS

PC TECH JOURNAL

DIRECT ORDER EXPRESS

Instant access to the latest products and services is just a phone call away

Programmer's Paradise 1-800-445-7899



WE'LL MATCH NATIONALLY ADVERTISED PRICES.

	LIST	OURS
386 SOFTWARE		
386/ASM/LINK	495	399
386MAX	75	66
386MAX PROFESSIONAL	129	115
F77L-EM/16 (FORTRAN)	695	629
F77L-EM/32	895	805
High C 386	895	799
Microport Sys. V/386 (Comp.)	899	799
Microsoft Windows/386	195	130
NDP C-386	595	529
NDP FORTRAN-386	595	529
SCO 386 XENIX Sys. V (Comp.)	1495	1195
VM/386	245	209
ASSEMBLY LANGUAGE		
386 ASM/LINK	495	399
Advantage Disassembler	295	279
ASMFLOW	100	90
Incra	180	CALL
MS Macro Assembler	150	105
Turbo Assembler/Debugger	150	112
Visible Computer: 80286	100	89
BASIC LANGUAGE		
db/LIB	139	121
FaceIt	99	90
Finally! XGRAF	99	90
Flash-up	79	70
GraphPak Professional	149	127

NEW RELEASES

Vermont Views 1.0
Vermont Creative Software's new generation of Windows for Data. User-interface library for forms, windows, menus, help, and keyboard handling. Menus in any style. Forms can be larger than display window, have choice lists, context-sensitive help, flexible decimal, date, time, and toggle fields. Mini word processor. International language portability.
List: $395 **Ours: CALL**

Microsoft QuickC V. 2.0
Now features incremental compilation and linking, resulting in greatly improved compilation speed. Also now includes a built-in, in-line assembler. Hypertext technology has been utilized in QuickC's new on-line reference system.
List: $99 **Ours: $69**

.RTLink
Fast, new overlay linker. User RTLs (Run Time Libraries) to prevent repetitive storage, on disk, of code that is common from one .EXE file to the next. Use of .RTLs results in significantly smaller .EXEs resulting in reduced disk space requirements.
List: $195 **Ours: $179**

	LIST	OURS
MS BASIC/6.0	295	199
MS QuickBASIC 4.5	99	69
SoftCode	79	69
Turbo Basic	100	75
C COMPILERS		
High C	595	549
Lattice C	450	289
Microsoft C	450	299
QuickC	99	69
Turbo C 2.0	150	112
Turbo C 2.0 Professional	250	187
Zortech C ++	150	129
C LIBRARIES/UTILITIES		
C ASYNCH MANAGER	175	129
C TOOLS PLUS/5.0	129	95
C Utility Library	199	139
CxPERT	395	335
Essential Communications	185	125
BreakOut Debugger	125	89
Greenleaf Business Mathlib	325	229
Greenleaf Comm Library	229	169
Greenleaf Functions	209	155
Greenleaf SuperFunctions	265	189
PC-lint	139	101
PforCe	395	215
/*resident C*/	99	79
w/ source code	198	159
Pro-C	495	459
TimeSlicer	295	279
w/ source code	1000	899
Turbo C TOOLS/2.0	149	115
C GRAPHICS		
Essential Graphics	299	229
GraphiC	395	322
GSS Graphic Dev. Toolkit	595	509
HALO '88	325	229
TurboHALO	100	80
C SCREENS/WINDOWS		
FaceIt	99	90
Greenleaf Data Windows	295	209
Greenleaf MakeForm	125	90
HI-SCREEN XL	149	129
JAM	750	684
PANEL Plus	495	395
SoftCode	79	70
Vermont Views	395	CALL
w/ source code	790	CALL
Vitamin C	225	162
VCScreen	149	109
COBOL LANGUAGE		
Micro Focus:		
COBOL/2 w/ Toolset	1800	1465
COBOL/2 Toolset	900	733
MS COBOL Version 3.0	900	599
Realia COBOL	995	799
w/ RealMENU	1145	929
RM/COBOL	950	763
dBASE LANGUAGE		
CLARION	695	629
Clear +	200	165
Clipper	695	439
dBASE IV	795	CALL

	LIST	OURS
dBFAST	100	75
Flipper	195	175
FoxBASE +	395	249
Genifer	395	259
Integrated Dev. Library	149	125
Magic PC	195	169
QuickSilver	599	369
R&R	150	125
w/ Clipper/FoxBASE module	199	179
SilverComm Library	150	139
Tom Rettig's Help	120	105
Tom Rettig's Library	100	75
XDB-SQL	495	419
DEBUGGERS		
386 DEBUG	195	145
Periscope I/512K	795	675
Periscope III	1395	1255
Quaid Analyzer	200	179
SoftProbe II/TX	395	359
DISK/DOS UTILITIES		
Advanced Norton Utilities	150	101
FASTBACK Plus	189	142
MACE Utilities	99	90
Magellan	139	CALL
Norton Commander	89	56
PC/Tools Deluxe	80	70
Vfeature Deluxe	120	111
X-Tree Pro	129	111
ZYINDEX 3.0	95	85
EDITORS		
BRIEF	195	CALL
KEDIT	150	120
MKS VI	149	125
Multi-Edit	99	90
Norton Editor	75	70
PC/EDT +	295	269
Pi Editor	149	129
Slick Editor	195	155
SPF/PC	245	185
VEDIT PLUS 3.0	185	115
FILE MANAGEMENT		
Btrieve	245	185
Xtrieve	595	459
Report Executive	149	109
Btrieve/N	595	459
CBTREE	159	141
c-tree	395	318
d-tree	495	395
r-tree	295	241
c-tree/r-tree bundle	650	523
CQL	395	332
dB_RETRIEVE	395	322
dB_FILE	395	322
XQL	795	599
FORTRAN LANGUAGE		
Grafmatic or Plotmatic	135	119
Lahey Personal FORTRAN 77	95	89
MS FORTRAN	450	299
RM/FORTRAN	595	479
SPINDRIFT Library	149	135
TEKMAR Graphics Library	195	169
OBJECT-ORIENTED PROGRAMMING		
ACTOR	495	423
C-talk	150	137
C_Talk/Windows	450	399
Smalltalk/V	100	85
Communications	50	45
EGA/VGA Color Ext.	50	45
Goodies #1, #2 or #3	50	45
Smalltalk/V 286	200	169
OPERATING SYSTEMS		
Concurrent DOS 386 (3 user)	395	349
Microport:		
System V/AT (complete)	649	549
AT Runtime System	249	209
PC-MOS 386		
1 User	195	179
5 Users	595	539

In NY: 914-332-4548
Customer Service: 914-332-0869
International Orders: 914-332-4548
Telex: 510-601-7602
Fax: 914-332-4021

Call or Write for Latest Free Catalog!

	LIST	OURS
SCO:		
XENIX System V (comp)	1295	999
Operating System	595	479
Wendin-DOS	139	109
PASCAL COMPILERS		
Microsoft Pascal	300	189
Turbo Pascal 5.0	150	112
Turbo Pascal 5.0 Professional	250	187
PASCAL LIB/UTILITIES		
B-tree Filer	125	99
DATABOSS	399	359
POWER SCREEN	129	95
T-Debug PLUS 4.0	45	40
w/ source code	90	79
Turbo ASYNCH MANAGER	129	99
Turbo Geometry Library	150	135
TurboMAGIC	199	179
TURBO META-MENU	149	139
Turbo-Plus 5.0	100	80
Turbo POWER TOOLS PLUS/5.0	149	115
Turbo Professional	125	99
TRANSLATORS		
Bas_C (Commercial)	375	323
Bas_Pas (Commercial)	280	242
BASTOC	495	399
dBx TRANSLATOR	550	469
PROMULA.FORTRAN	450	409
OTHER PRODUCTS		
APL*PLUS PC	695	529
Dan Bricklin's Demo Program II	195	179
FLOW CHARTING II	229	207
Greenleaf ViewComm	495	CALL
LINK & LOCATE ++	395	359
MKS Toolkit	199	165
Norton On-Line Prog. Guide	100	75
Opt-Tech Sort	149	105
PCYACC	395	359
Pfinish	395	215
Plink86plus	495	279
PVCS (Corporate)	395	322
Source Print	97	80
Tree Diagrammer	77	70

This Month's Specials *from* *MORTICE KERN SYSTEMS*

	LIST	OURS
MKS AWK	99	82
MKS LEX & YACC	249	207
MKS Make	149	125
MKS RCS	189	157
MKS SQPS	495	479
MKS Toolkit	199	165
MKS Trilogy	119	99
MKS VI	149	125

PROGRAMMER'S POLICIES

Phone Orders
Hours 9 AM-7 PM EST. We accept MasterCard, Visa, American Express. Include $4.00 per item for shipping and handling. All shipments by UPS ground. Rush service available.

Mail Orders
POs by mail or fax are welcome. Please include phone number.

International Service
Phone number required with order. Call or fax for additional information.

Dealers and Corporate Accounts
Call for information.

Unbeatable Prices
We'll match nationally advertised prices. (Subject to same terms and conditions.)

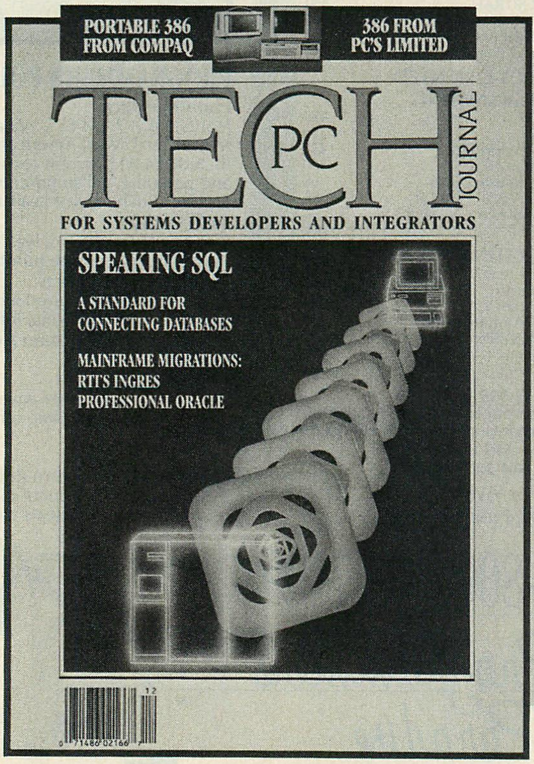
Return Policy
30-day no-hassle return policy. Some manufacturer's products cannot be returned once disk seals are broken.

1-800-445-7899

Programmer's Paradise ™

A Division of Voyager Telemarketing
55 South Broadway, Tarrytown, NY 10591

CIRCLE NO. 173 ON READER SERVICE CARD


PORTABLE 386 FROM COMPAQ
386 FROM PC'S LIMITED
TECH PC JOURNAL
FOR SYSTEMS DEVELOPERS AND INTEGRATORS
SPEAKING SQL
A STANDARD FOR CONNECTING DATABASES
MAINFRAME MIGRATIONS: RTI'S INGRES PROFESSIONAL ORACLE

PC TECH JOURNAL MARKETPLACE

PRODUCT CATEGORIES

HARDWARE 137-139

SOFTWARE 139-144

MISCELLANEOUS 144-145

ADVERTISING RATES AND INFORMATION

PC Tech Journal Marketplace is a comprehensive buyer's guide for systems developers and integrators. Special economical section for product and service listings.

Listings are grouped by category and sold by column inches. Second color option available.

Standard Directory Listings are also available for a minimum of 3 issues at $240.00 per issue ($720 total).

For additional information call 212-503-5115 or 800-825-4237.

ACCOUNT MANAGERS

Michael J. King, Account Representative
(212) 503-5116

WA, HI, AZ, MT, NV, ID, ALL CA, NM, UT, CO, OR, WY, Canada

Steve Russell, Account Representative
(212) 503-5141

AK, AL, AR, DC, DE, FC, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, MI, MN, MO, MS, NB, NC, ND, NJ, OH, OK, PA, SC, SD, TN, TX, VA, WI, WV, CT, ME, NH, NY, RI, VT, British Columbia (All Overseas Calls)

CLASSIFIED ADVERTISING STAFF

One Park Avenue, New York, NY 10016
(212) 503-5115

Group Advertising Director
Kathryn J. Cumberlander

Group Sales Manager
Daniel L. Rosensweig

Sales Manager
Phyllis A. Kenny

Advertising Support Manager
Monica Dixon

Advertising Coordinator
Elizabeth Lopez

Production Director
Anne R. Brockinton

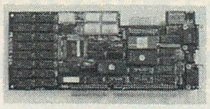
Production Coordinator
Ann M. Sheridan

TECH PC JOURNAL MARKETPLACE

THE COMPREHENSIVE BUYER'S GUIDE FOR SYSTEMS DEVELOPERS AND INTEGRATORS

HARDWARE/BOARDS

PEACOCK™ EVGA–16 BIT



Made in USA

Allstar's new Peacock™ VGA PLUS gives you SIXTEEN BIT all mode performance. Offers IBM register-to-register compatibility with BOTH TTL and Analog connectors. PS-2 Feature Connector with 512 K High Speed RAM and Five crystal controlled frequencies. Device drivers are provided for GEM, Autocad V-9, Lotus 1 2 3, Ventura, Windows 386 and others.

PEACOCK™ VGA Plus Does It All —

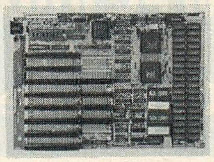
- VGA +; VGA; EGA; CGA; MDA; MCGA; & Hercules
- 16 BIT Performance (Also XT Compatible)
- 300 x 200/256; 640 x 480/256; 800 x 600/16; 800 x 600/256; 1024 x 768/16 Colors
- Both Analog and TTL Monitors Supported
- 512k High Speed RAM
- 80 COL x 66 ROWS Plus 132 COL x 44 ROWS
- Interlaced and non-Interlaced Supported

List: $645

See us at COMDEX/Spring '89

TRANSFORMER™ FOR PC & XT

Put the "Real Thing" in your older IBM PC or XT!



Made in USA

The Transformer™ 286-12 MHZ is a direct form, fit, and function, replacement board. Offered in two versions: 5 slots for PC's, 8 slots for XT's, plug compatible with all original PC/XT cards, operating devices, power supply, controllers, drives, including keyboards.

Converts your old IBM PC or XT into a true 12 MHZ 16 BIT AT BUS system.

Suggested Retail $695

- Memory partitions: 512K • 640K • 1 MB on board
- DOS, OS/2, UNIX, Novell, and Token Ring Compatible
- Norton SI: 1 WAIT-13.3; 0 WAIT-15.7
- AWARD Bios with ROM setup
- VSLI chip set 10 or 12 MHZ Ver.
- 6/12 MHZ, HW/SW selectable
- 30 Day Money-Back Guarantee, 1 yr. Warranty
- (VARS, VAD & OEM discounts)

ALLSTAR

Allstar Microsystems Corp.
13885 Alton Parkway, Irvine, CA 92718 • (714) 951-1884 • FAX (714) 951-2897 • **(800) 525-2860**

CIRCLE 265 ON READER SERVICE CARD

COMMUNICATIONS

AIS INC
421 E. Palatine Rd.
Palatine, IL 60067

312·359·2626

Software Link Inc:

Multilink Advanced®	$399
Lanlink ™ 5.0 starter kit	$349
Lanlink ™ 5.0 satellite	$79
Lanlink™ 5X Server	195
Lanlink™ 5X satellite	$85
AT Gizmo™	$259
PC-Emulink™	$135
PC-MOS™ single user	$135
PC-MOS™ five user	$425
PC-MOS™ 25 user	$650

Digiboard serial boards:

4S 4 port 16 bit I/O	$335
8S 8 port 16 bit I/O	$525
4I 4 port Intell I/O w/256k	$678
8I 8 port Intell I/O w/256k	$836
Call for PS-2 I/O boards	

CIRCLE 271 ON READER SERVICE CARD

NEW LDP-VGA BOARD NEW

- 16 Bit Data Path
- Fully VGA™ compatible down to register level
- High Resolution 1024 X 768 display
- Either 256K or 1 Mbyte of display memory

$475.00 256K

LDP-CACHE SCSI DISK CONTROLLER

- Up to 1 Mbyte of Cache Memory for Drive Data
- Controls up to 7 SCSI Devices
- Caches both read and write operations
- Improves Disk System performance 300% to 1000%

$649.00 256K Version

LOMAS DATA PRODUCTS, INC.
182 Cedar Hill St., Marlboro, MA 01752
508-460-0333

CIRCLE 266 ON READER SERVICE CARD

DISTRIBUTORS & DEALERS WANTED

- For high performance SCSI host adapter
- For Superfast ESDI to AT Bus 16 Bit controller with 15MB/s transfer rate

Contact ITD Corp.
Phone: 408-737-3900
FAX: 408-737-3910

CIRCLE 269 ON READER SERVICE CARD

COMPANION

Companion allows you to add an extra keyboard and monitor up to 250' from your PC system unit.

*** Now available for VGA and PS/2. ***

DEALER PROGRAM AVAILABLE
PRICES START AT $219.00

CYBEX CORPORATION
2800 H. Bob Wallace Ave
Huntsville, AL 35805
(205) 534-0011

CIRCLE 272 ON READER SERVICE CARD

IEEE 488 Solutions

- Hardware and software for PC, AT, 386, PS/2, Macintosh, HP, SUN & DEC
- IEEE device drivers for DOS and UNIX®
- IEEE control for Lotus 1-2-3 & Symphony
- PC menu-driven analysis software
- IEEE extenders, expanders & buffers
- IEEE converters to RS-232, RS-422, SCSI, modem, Centronics, analog I/O & digital I/O

Call or send for your FREE Technical Guide
Demo disks and application notes available

IOtech
(216) 439-4091
Telex 6502820864 • Fax (216) 439-4093
IOtech, Inc. • 25971 Cannon Road
Cleveland, Ohio 44146

CIRCLE 267 ON READER SERVICE CARD

Don't Write It Off!

5G will remanufacture your PC, XT or AT for a new life as a high-speed 80386 system.

- *100% new internals*
- *Only the best components*
- *Long life, high reliability*
- *Wide range of options*
- *Full warranty*

You don't need a new box- **it's what's inside that counts.** Call or write for our full catalog.

5G Corporation
4131 Spicewood Springs Rd., A-4
Austin, Texas 78759
800-333-4131 • 512-345-9843

CIRCLE 268 ON READER SERVICE CARD

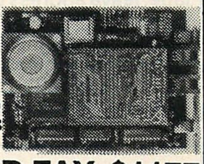
METRO COMPUTER CORPORATION

EVEREX 386/25, 4 MB, 44 MHD w/VGA	$7695
UBM 386/20, 1 MB, 44 MHD w/EGA MON	$3295
COMPAQ Lap-Top w/20 MBHD	$4495
ALR 286/12.5 1 MB, 44 MHD w/mono	$2495
IBM/COMPAQ/AST/ALR	Call for pricing
KURTA IS/ONE, 12x12 w/single pen	$475
CALCOMP 23120, 12x12 w/4 button	$395
SUMMASKETCH, 12x18	$725
OTHER DIGITIZERS MODELS	Call for pricing
IOLP3700, A-E SIZE, 1 PEN	$3450
CALCOMP, 1043GT, 8 PEN	$6735
HP 7595A, A-E, 8 PEN	$8750
DXY 990, A-B, 8 PEN	$1499
PHOTON 800 ....$705 PHOTON 1000+	$995
NUMBER NINE PEPPER PRO - 1280	$2395
PAGEMAKER 3.0 ..$555 LOTUS 123	$335

Call for what is not listed
1345 S. Anaheim Blvd., Anaheim, CA 92805
TEL: 714-778-6495 FAX: 714-778-6877

CIRCLE 270 ON READER SERVICE CARD

FAXBOARD $455



- 9600 BPS MODEM INCLUDED
- NO SEPERATE LINE NEEDED
- PAPERLESS SECURITY

BEYOND FAX $1177
SEND VOICE,DATA & COLOR GRAPHIC

SMART 8,16 PORT RS232 CARD
FOR NETWORKING **$700,$888.**
& PS/2 MODEL 80 VERSION.
THESE ARE FEW OF OUR PRODUCTS
ASK FOR LATEST CATALOGUE

MAXTRON (818) 350-5707
1825A Durfee Ave., S. El Monte, CA 91733

CIRCLE 273 ON READER SERVICE CARD

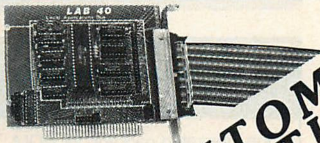
Tech Marketplace

The Comprehensive Buyer's Guide For Systems Developers and Integrators

HARDWARE

HARDWARE

PERIPHERALS



AUTOMATE ANYTHING

With your PC & LAB 40

Local Applications Bus.

Ribbon cable, daughter board system.

Daughter boards for:
- **STEPPER** 4 axes with software **$150.**
- **DC SERVO** CNC, contouring, expandable.
- **FAST A/D** 650KHz, Scope/FFT **$220.**
- 12 Bit A/D • Relays.
- RS-232 control option.

For **FREE TECHNICAL CONSULTATION, FREE** literature, and orders call (415) 755-1978

FREE SOFTWARE WITH SOURCE CODE
Call BBS (415) 755-1524
use modem 24 hours

Computer Continuum
75 Southgate Ave., Daly City, CA 94015
(415) 755-1978

CIRCLE 277 ON READER SERVICE CARD

"NOBODY"

We asked our customers to tell us who had LOWER PRICES than we do.

They told us!

We lead the industry both in price and quality in ½" 9-track tape drive subsystems to transfer information between mainframes and PC/XT/AT, PS2.

- EBCDIC-ASCII Conversion
- Tape backup/volume data stg.
- Speed is up to 7 Meg/min.
- Select & reject specific fields
- 800/1600/6250 BPI
- Drives from Anritsu, Cipher, Qualstar and M4 Data

Dealer & Volume Discounts

FLAGSTAFF ENGINEERING
1120 Kaibab Lane • Flagstaff, AZ 86001
(602) 779-3341 • Telex 705609
FAX (602) 779-5998

CIRCLE 280 ON READER SERVICE CARD

9-TRACK MAG. TAPE SUBSYSTEM FOR THE IBM PC/XT/AT AND...

For information interchange, backup and archival storage, AK Systems offers a 9-track, IBM format-compatible ½" magnetic tape subsystem for the IBM PC, featuring:

- **IBM format 1600/3200 and 800 cpi.**
- **Software for PC-DOS, MS-DOS, XENIX.**
- **Also for AT&T, DEC, VAX, VME, S-100, RS-232, IEEE 488.**

AKSystems
20741 Marilla St.
Chatsworth, CA 91311
(818) 709-8100
TWX: 910-493-2071

Write, phone or TWX for information.

CIRCLE 278 ON READER SERVICE CARD

9-Track Tape Subsystem

MINISTREAMER™

Now you can exchange data files between your IBM PC/XT/AT and any mainframe or mini-computer using IBM compatible 1600 or 6250 BPI 9-Track tape. Unit can also be used for disk backup. Transfer rate is up to 4 megabytes per minute on PCs and compatibles. Subsystems include 7" or 10½" streaming tape drive, tape coupler card, cables and software.

QUALSTAR®
9621 Irondale Avenue
Chatsworth, CA 91311
Telephone: (818) 882-5822

CIRCLE 279 ON READER SERVICE CARD

SPEECH SYNTHESIS

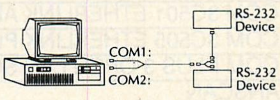
SynPhonix: TRUE Unlimited Speech Synthesizer for IBM-PC/XT/AT/jr & compatibles. This low power short card includes an SSi263 speech chip, amplifier and speaker. Software includes Text-to-Speech, Phonetic Editor, Talking Clock & demos. Can be programmed with BASIC and other languages. Prices start below $200.

SynPhonix™
Electronic Speech Articulator

Artic Technologies
55 Park St., Suite 2
Troy, MI 48083
(313) 588-7370

SOFTWARE/ COMMUNICATIONS

Communications Analyzer



- Monitors and stores to disk RS232 async data in real time
- Dual line DCE over DTE format
- Perform action on any data pattern
- Interactive mode
- Fully configurable, includes cables
- For IBM/PC/XT/AT or compatibles

Palladian Technologies Incorporated

$395.00
demo $10

1-800-537-5046 (301)576-0575

CIRCLE 281 ON READER SERVICE CARD

COMMUNICATIONS

SOFTLINK COMMUNICATION SOFTWARE FOR EMULEX COMMUNICATION HARDWARE

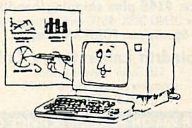
COMMUNICATION SOFTWARE FOR EMULEX DCP FAMILY OF INTELLIGENT COM PROCESSORS. HIGH PERFORMANCE SOFTWARE TO HANDLE ASYNC AND SYNCHRONOUS LINES. SUPPORT TO 24 ASYNC COM LINES UNDER DOS. USE SOFTLINK SOFTWARE AND YOUR APPLICATION TO INTERFACE WITH OTHER COMPUTERS AND DEVICES.
- Bar Code Readers
- Lottery System Communications
- Security System Links
- POS Terminals
- Synchronous Links
- Medical Office Low Cost Terminals

SOFTLINK
16478 Beach Blvd. Ste 301
Westminster, CA 92683
Phone (714) 839-8963
Telex 9102504895

CIRCLE 282 ON READER SERVICE CARD

GRAPHICS

PlotIT®



Interactive Graphics & Statistics

Create graphs the way you want them. 35 graph types can be used to create numerous renditions. Make posters and flow charts—with full screen editing of text.

- Vary character font, size, position, color
- Stack and overlay graphs
- 3-Dimensional graphs: fishnet & contour
- Linear & Non-Linear Regression
- Stochastic Distribution
- Independence Testing
- Descriptive Statistics

Contact: Scientific Programming Enterprises, P.O. Box 669, Haslett, MI 48840 (517) 339-9859

CIRCLE 283 ON READER SERVICE CARD

FORTRAN Graphics Libraries

Now! 3 scientific graphics packages to support MS FORTRAN/Pascal, R-M or Lahey FORTRAN. GRAFMATIC (screen), PLOTMATIC (HPGL, H-I plotter) & PRINTMATIC (Laser & dot-matrix printer). All fully documented. Complete graphics primitives, 2-D plots, 3-D plots and solid models. $135 each, 2 for $240, all 3 only $340. Call or write for info.
Microcompatibles, Inc.
301 Prelude Drive Dept. J
Silver Spring, MD 20901
(301) 593-0683

Tech Marketplace
Second Color Option Available

Tech Marketplace
Standard Directory List Available

HARDWARE • SOFTWARE

TECH PC JOURNAL MARKETPLACE

THE COMPREHENSIVE BUYER'S GUIDE FOR SYSTEMS DEVELOPERS AND INTEGRATORS

SOFTWARE • PROGRAMMERS TOOLS

GRAPHICS

35mm SLIDE FROM YOUR PC
COMPUTER SLIDE EXPRESS converts graphic files produced on the IBM PC into brilliant 35mm color slides with color resolution 400% better than your monitor. Leave your printouts behind. Use high resolution color slides up to 4000 line. COMPUTER SLIDE EXPRESS $9/slide.
VISUAL HORIZONS
180 Metro Park
Rochester, NY 14623
(716) 424-5300

LANGUAGES

THE SPINDRIFT LIBRARY

At last!! Now there's a way for the FORTRAN programmer to do the things they have always wanted to do: Execute other programs via CALL EXEC; direct control of the cursor with edit keys; WINDOWS on the screen for POP UP HELPs; (*) and (?) wildcard file searches; save/restore screen images; COLOR screens.

These are just a few of the features of the SPINDRIFT Library. Over 150 subroutines and functions in all, the SPINDRIFT Library includes DOS Interface (COPY, ERASE, MKDIR, FINDFILE, SYSTEM, etc), Variable Length Strings, Security Routines, Date/Time Routines, 10 SORT Routines, and much more!

Price: $149 plus shipping/handling
Write for a DEMO DISK: $5.00 credited toward purchase.
Specify your FORTRAN Compiler

Spindrift Laboratories, Ltd.
116 South Harvard Avenue
Arlington Heights, Illinois 60005
(312) 255-6909

CIRCLE 284 ON READER SERVICE CARD

NETWORKING

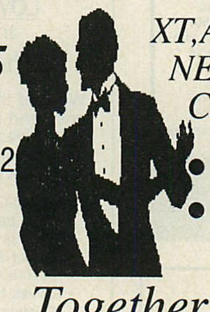
NETWORK CONTROL LIBRARIES
NETWORK INTERFACE allows file sharing and redirection through DOS functions. $99. NETBIOS ROUTINES allows access to low-level network functions. Name, session & datagram routines. Wait and no-wait options. $199. NETWORK MASTER provides access to Netware internal functions. $299. Complete network control from your compiled programs!
..........Starlight Software..........
..........P.O. Box 1090..........
.........Wheeling, IL 60090.........
..........(312) 394-0622..........

Tech Marketplace
The Comprehensive Buyer's Guide For Systems Developers and Integrators

NETWORKING

BoxNet™ IV

LOCAL AREA NETWORK



$99.95 *PER NODE*

XT,AT,PS2 NETBIOS COMPATIBLE

- Joins up to 12 computers
- Runs in the background
- Easy to use
- Used RJ-11 cable and serial port

Together BoxNet™ made it possible

Box #1
PO Box #1, Bath, NY, 14810-0001
800-541-2691
607-569-2376

CIRCLE 285 ON READER SERVICE CARD

3COM 3C503 INTERFACE	$295
NOVELL NETWARE 286 2.12	$1695
3S200 SERVER	CALL
3S400 SERVER	CALL
3COM MODULAR REPEATER	$995
3COM 3C501 ETHERLINK ADAPTOR	CALL
3COM 3C505 ETHERLINK PLUS ADAPTOR	CALL
3COM PLUS 3 OPEN LAN SOFTWARE	$2895
LANSCAN	$995
3 STATION 1 MB	$1895

CSS (714) 528-6488 FAX: (714) 528-6991

CIRCLE 286 ON READER SERVICE CARD

The $25 Network

Try the 1st truly low cost LAN

- Connect 2 or 3 PCs, XTs, ATs
- Uses serial ports and 5 wire cable
- Runs at 115 K baud
- Runs in background, totally transparent
- Share any device, any file, any time
- Needs only 14K of ram

Skeptical? We make believers!

iModes
Information Modes
P.O. Drawer F
Denton, TX 76202
817-387-3339

CIRCLE 287 ON READER SERVICE CARD

KEYCARD ELIMINATOR

KEYCARD ELIMINATOR 4.61, 86, 2.0a, 2.1, & 2.11 FREE A SLOT! $99	D C B ELIMINATOR 2.0a, 2.1, & 2.11 TRUE SFT! $99
ELS UTILITIES KYBD & PrtSc FIX WP 5.0 FIX $59	NETCRACK LOSE PASSWORD? ALL VERSIONS $99
GETDISK GET BIOS DRIVES 286 & 386 $59	BIOS TOOLS PATCH DRIVE TABLES INCL GETDISK $99

(713) 781-9268
NBS
NETWORK BUSINESS SYSTEMS
1300 WOODHOLLOW DRIVE, SUITE 5601
HOUSTON, TEXAS 77057
NOVELL AUTHORIZED RESELLER

CIRCLE 288 ON READER SERVICE CARD

PROGRAMMERS TOOLS

ROM Microsoft-C $495

One integrated package for ROM development with Microsoft-C®. The package has full Source level remote debugger (locals, register variables), 8086 locator that produces Intel hex, Absolute OMF (with locals and Basic types), Startup code, and a ROMable library (printf).

Free ROM-Essentials Guide...
CALL FOR MORE INFO

Datalight
17505 - 68th Ave. N.E., #304
Bothell, WA 98011 USA
(206) 486-8086
1 (800) 221-6630

SOURCE CODE NO ROYALTIES

BOSS INTEGRATED ACCOUNTING VERSION 2.0
Slash development costs with BOSS ACCOUNTING. Fully integrated modules including **G/L, A/R, A/P, PAYROLL** and **INVENTORY**. Complete **PASSWORD SECURITY. MULTI USER / NETWORK** compatible. **BOSS** is available for QuickBASIC 4.x or IBM BASCOM 2.0. Features clean well annotated code. Easily modified. No licensing fees. All resale profits are yours!!!

ONLY $995.00

Ask about our
- ISAM interface to QuickBASIC 4.x
- Vertical market applications

LAKESHORE COMPUTING, INC.
1105 North Front Street, Niles, MI 49120
1-800-345-4214 in MI **616-684-5120**
CALL TODAY

CIRCLE 289 ON READER SERVICE CARD

BTAGS brings UNIX™ POWER to MSDOS™!

UNIX™ programmers rely on CTAGS to edit complex sets of source files. Now BTAGS adds this powerful capability to MSDOS editors like PC/VI, Z and BRIEF!

BTAGS gives MSDOS users the power to edit large projects efficiently. Don't recognize a function call? A single keystroke shows you the body of the function, even if it is within a different file in a distant directory! No need to hunt through a dozen C source files for that utility you'd like to reuse: with BTAGS you view it instantly, by function name!

Order with VISA or MASTERCARD or send $49.95 plus $3 shipping to:
SD Enterprises Ph. (503) 663-2865
P. O. Box 1233. Gresham OR 97030
Specify 5 1/4" or 3 1/2" media with your order.

CIRCLE 290 ON READER SERVICE CARD

TECH PC JOURNAL MARKETPLACE

THE COMPREHENSIVE BUYER'S GUIDE FOR SYSTEMS DEVELOPERS AND INTEGRATORS

PROGRAMMERS TOOLS

TECH PC JOURNAL MARKETPLACE

THE COMPREHENSIVE BUYER'S GUIDE FOR SYSTEMS DEVELOPERS AND INTEGRATORS

PROGRAMMERS TOOLS

PROGRAMMERS TOOLS

TECH PC JOURNAL MARKETPLACE

THE COMPREHENSIVE BUYER'S GUIDE FOR SYSTEMS DEVELOPERS AND INTEGRATORS

PROGRAMMERS TOOLS

COMPRESS YOUR DATA!

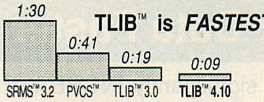
ARC is considered the industry standard archive utility. It's the file storage method used by PCTECHline. And PC WEEK called it "A sophisticated and eminently useful product."

ARC automatically compresses stored data so it takes up less space. And less modem transfer time. From 20% to 90% less, depending on the kind of data.

All program sources are included and it's not copy protected .... **$50 ARC**

System Enhancement Associates
21 New Street, Wayne, New Jersey 07470•(201) 473-5153

CIRCLE 298 ON READER SERVICE CARD



TLIB™ is FASTEST!

Times are to update a 45K library on a PC/XT. PVCS and TLIB 3.0 are from Sept 87 *PC Tech Journal*. SRMS and TLIB 4.10 are later versions.

TLIB™ is *BEST!*

"Do not be fooled by the fact that this is the least expensive of the five packages reviewed here - TLIB has features and power to spare" John Rex, **Computer Language**

"TLIB is a great system" J. Vallino, **PC Tech J**

- **Full-Featured Version Control for Software Professionals.** Check-in/out locking. Branching. Keywords. Wildcard and list-of-file support. Can merge parallel changes and undo intermediate revisions. Network and WORM support. **Mainframe compatible** deltas for Pansophic, ADR, IBM, Sperry. Integrated Landon Dyer PD **MAKE.**

MS-DOS 2.x, 3.x, 4.x ***Just $99.95*** + $5 s/h Visa/MC
5 station LAN license $299.95 + $5 s/h, call for other sizes

BURTON SYSTEMS SOFTWARE
PO Box 4156, Cary, NC 27519 (919) 856-0475

CIRCLE 371 ON READER SERVICE CARD

ENTRYPOINT 90

Develop custom PC data entry applications. Powerful validation, editing, audit trails, accumulator balancing, math functions and programmable keyboard make Entrypoint 90 ideal for high-volume data entry in distributed, LAN and standalone environments.

Accepts scanned input, interfaces with communications packages, integrates external C procedures. Excellent for OEM/VAR apps and as front-end to commercial networks. Award-winning manuals, excellent tech support, menu-driven application developer system and paint-the-screen image editor make conversion quick and easy.

Call for a free demo diskette or Application Catalog. Ask about our Reseller program.

DATALEX
100 Pine Street, Suite 2400
San Francisco, CA 94111
800-962-8888 415-362-4466

CIRCLE 374 ON READER SERVICE CARD

BIOS SOURCE CODE

The **The AT BiosKit** is a book with diskettes containing source code in C, plus utility programs to help you create a Bios. Now you can have a Bios with documentation for your own applications: modify boot-up, eliminate the keyboard, install security features, etc. Only $199 complete. The **XT BiosKit** is only $99, or get both BiosKits for $279. The **Intel Wildcard Supplement** for the XT BiosKit is $49.

— XT-AT HANDBOOK —

The **XT-AT Handbook** is full of hardware and software information in a shirt pocket size book. Over 70 pages covering 38 subjects, including connectors, I/O maps, controller programming, DOS and DEBUG commands, board dimensions, character codes, hard disk drive types, and much more. Only $9.95 each qty 1-4, five or more, $5 each.

Annabooks
12145 Alta Carmel Ct Suite 250-262
San Diego, California 92128
(619) 271-9526

CIRCLE 370 ON READER SERVICE CARD

ATTENTION IBM ARTIC CARD SOFTWARE DEVELOPERS

Finally! A realtime software debugger for IBM ARTIC cards. ARTICEB allows concurrent debugging sessions on as many ARTIC cards as you have in a system unit. Many advanced features.

- Debug hardware and software interrupt handlers.
- Full screen tracing includes backwards tracing up to 64 steps.
- Menu driven system statistics include...

Buffer control blocks, Dispatch Registers and Flags, Interface Block, Primary and secondary status, QUEUE Elements, Software Timers, Task Control Blocks, Task Headers, Task Table.

- When you use ARTICEB, debugging proceeds at about 10 times faster than it can with other existing ARTIC software debuggers.

ATLANTIC FIRMWARE
(609) 795-9651

CIRCLE 272 ON READER SERVICE CARD

BASIC to C

BASC_C v3.2 accepts BASICA, Quick BASIC, CBASIC86 and most other BASICs by adding the syntax & generation rule of new statements & functions (Customizer). Generates structured, indented, scoped MS/Turbo/Latice/Aztec C. All memory models and compile options are supported. C source (Runtime Library) incld. For MS/DOS, XENIX, UNIX. Demo disk. From $199.
GOTOLESS CONVERSION
P.O. Box 835910
Richardson, TX 75083
(214) 404-1404

HyperDraw for the IBM PC

ATTENTION PROGRAMMERS! Create database stacks for the PC family using the new HyperDraw features of PC-KEY DRAW Version 3.5. Use powerful graphics editor with freeform Hypertext for creating the databases of the future. Hundreds of applications. Only $100 for full registered version.
OEDWARE
P.O. BOX 395
Columbia, MD 21045-0595
(301) 997-9333

OS/2 'C' LIBRARY

—Complete 'C' Development Library—

The following libraries provide support for DOS AND OS/2

Database - Index File Manager for Disk & RAM-Based Data, with add, delete, first, last, next, previous, rekey, relative, etc. Binary & Text keys. Uses multi-tree binary technique. $150

Graphics - OS/2 Support (including Bar, Pie, Line Charts, Fonts, etc). Allows development of graphic programs under OS/2 w/o the hardware overhead of the Presentation Manager. $200

Plotter/PaintJet - Full support, including 2-D Bar, 3-D Bar, Pie, Line, & Fonts: $100

Screen Manager with external screen creation, field definition & support for full screen editing: $125

General Library - 150 + functions to support mouse, date/time, text video, windows, sorting, music, encryption, math, keyboard, and more: $95

All Libraries: $500.00

Source code included. No royalities for Distribution of Executable Programs. Demo Disk: $10.

CETREST Corp. PO Box 813, Woodstock, GA 30188 (404) 924-6820 MasterCard, Visa, Check, MoneyOrder.

CIRCLE 373 ON READER SERVICE CARD

ARRAY SUBROUTINES

Faster development and execution, 174 assembled routines for interpreted or compiled BASIC, Assembler, Pascal, C.Qsort, grade, resequence, expand, locate, compare, etc for floating point, integer, and string variables; and add, and, rotate, shift, xor, etc for logical (binary) vectors, $49.99.
..........uniSON Software..........
............Box 2033..............
......Moose Jaw, Sask. S6H-7N7......
........Canada, (306)-694-0072........

SAVE DEBUGGING TIME!

WATCH-I/O is a popup utility that shows names and technical info of all files in use. WATCH-I/O also shows name of last file opened, current program name, and last file-not-found. Only $24.95 + $5 S&H Visa/MC/CK/MO.
Quantum Publishing
23860 Miles Road
Cleveland, OH 44128
1-800-342-6237

BTRIEVE™ BTRIEVE™ BTRIEVE™

If you use Btrieve, you must have BUTILITY. BUTILITY is the only way to edit and create Btrieve files (ver 4.0 and up). Stop wasting time writing those utility programs! Use QB 4.0 look and feel editor to perform all operations, edit the data buffer, edit actual key values, search and replace, and much, much more. Only $89.95 + $5 S&H. MC VISA or COD.
SMITHWARE, Inc.
147 Harpeth Trace Drive
Nashville, TN 37221
(615) 352-2221

SOFTWARE PACKAGING

Software Packaging & Computer Supplies

• IBM style binders & slip cases - blank or printed • Vinyl binders & slip cases • Vinyl folders & packages • Continuous & cut sheet paper for manuals 5-1/2 x 8-1/2 • Disk pages • Disk envelopes • Continuous & laser labels • Shipping cartons & envelopes for software & MORE !!

Call For A Free Catalog!!
800-DEAL-NOW 312-629-5160
Anthropomorphic Systems, Ltd.
376-J East Saint Charles Road
Lombard, IL 60148

CIRCLE 375 ON READER SERVICE CARD

SECURITY DEVICES

EVERTRAK

SECURITY

If you HATE Copy Protection, but still want to protect your program from hackers and reverse engineering, EVERTRAK allows you to:

- Shut down DEBUG systems and disassemblers.
- Restrict use by date-range and media-type.
- Embed a secure serial number string.
- Track unauthorized copies back to their source.

EVERTRAK is totally invisible to your end user and uses the latest encryption technology.

EVERTRAK supports IBM & Compatibles using DOS 2.0 or later, sells for $295.00 and has a 30 day money back guarantee.

Az-Tech Software, Inc.
305 East Franklin
Richmond, MO 64085
(800) 227-0644 (816) 776-2700

CIRCLE 376 ON READER SERVICE CARD

EVERLOCK

COPY PROTECTION

Designed for user-transparency, clone compatibility & strength. It features:

- no need for damaged media or I/O plugs
- thwarts all Bit-copy Software
- supports all Hard & floppy Disk formats
- restrict or allow Network Installs
- allows protected upgrades by modem/BBS
- limit program use by Date or #Executes
- remotely reset Installs or Expiration

$195 Starter Kit or $495 with NO meter counts. Free info & demo disk available.

Az-Tech Software, Inc.
305 East Franklin
Richmond, MO 64085
(800) 227-0644 (816) 776-2700

CIRCLE 377 ON READER SERVICE CARD

BIT-LOCK® SECURITY

Piracy SURVIVAL 5 YRS proves effectiveness of powerful multilayered security. Rapid decryption algorithms. Reliable security device transparent to PARALLEL or SERIAL port. Complemented by low cost KEY LOK™ & multifeatured COMPU-LOCK™. Including countdown, time-out, data encryption & multiproduct protection.
MICROCOMPUTER APPLICATIONS
3167 East Otero Circle
Littleton, CO 80122
(303) 922-6410 or 770-1917

To Place Ad Call
800-825-4ADS

PROGRAMMERS TOOLS • SOFTWARE

TECH PC JOURNAL MARKETPLACE

THE COMPREHENSIVE BUYER'S GUIDE FOR SYSTEMS DEVELOPERS AND INTEGRATORS

SOFTWARE • MISCELLANEOUS

TERMINAL EMULATION

BARR High-Performance RJE Workstations

BARR/SNA RJE and BARR/HASP are communications hardware/software packages for the IBM PC and PS/2 series of computers.

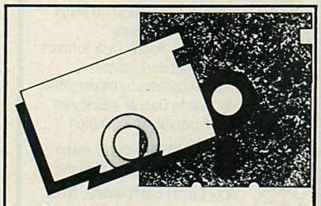
Full featured:
- multiple printers,
- unattended operation,
- print speed beyond 6,000 lpm,
- special forms,
- line speed to 56,000 bps,
- dial-up or dedicated lines, and
- serve as a LAN gateway.

BARR/SNA RJE emulates IBM 3777-3 in an SNA environment. BARR/HASP emulates IBM 3777-2 and HASP on the 360/20. BARR communications software is also available with PC-SYNC internal modems: 208AB, 201C, 9600.

BARR
Barr Systems, Inc.
2830 NW 41 St. Bldg M
Gainesville, FL 32606
800-BARRSYS or
904-371-3050

CIRCLE 378 ON READER SERVICE CARD

UTILITIES



ADD UP TO 60% MORE DISK CAPACITY WITH AXE.

AXE is a program compression utility from SEA, the company that wrote the industry standard for archiving files. AXE compacts .EXE and COM files so you can reclaim up to 60% of disk space with no sacrifice in power and no hardware updates.

Call today for more information on how you can reclaim space and retain power with AXE.

(201) 473-5153

sea SYSTEM ENHANCEMENT ASSOCIATES
21 New Street, Wayne, NJ 07470

CIRCLE 379 ON READER SERVICE CARD

UTILITIES

Compress Your Data Faster and Smaller!!!

- PKZIP and PKUNZIP can significantly INCREASE DISK STORAGE CAPACITY and reduce file transfer times!
- PKZIP ensures data integrity by use of a 32-bit Cyclic Redundancy Check (CRC).
- PKZIP can retain the subdirectory hierarchy and PKUNZIP can extract the files to the correct subdirectory AUTOMATICALLY.
- PKSFX can conveniently create SELF-EXTRACTING files.
- SITE and DISTRIBUTION licenses are available. Not copy protected.

VISA® MasterCard®

Only $47.00 + 3.50 s/h. WI res. add 5% sales tax. FAX (414) 352-3815
7545 N. Port Washington Rd., Glendale, WI 53217 (414) 352-3670
PKware Inc.

CIRCLE 380 ON READER SERVICE CARD

If you can find better sort/merge software, buy it!

Sortex®
Ultimate in performance and reliability

30-Day Money-Back Guarantee
Only $149.95

Systemat CORPORATION
1915 W. Orangewood Avenue, Suite 200
Orange, California 92668
PHONE: 714 978 0480
FAX: 714 978 7912 TWX: 910 250 0674

CIRCLE 381 ON READER SERVICE CARD

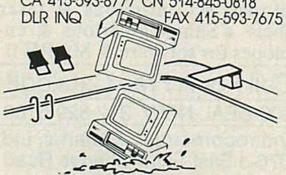
BRIDGE-IT™ 3.5

3.5" FLOPPY SOFTWARE DRIVER

- FORMAT/COPY SUPPORT FOR 720/1.44 CAPACITY
- NO NEED TO UPGRADE DOS OR CHANGE BIOS
- USE WITH PC/XT/AT CLONES DOS 2.0+
- BRIDGE THE GAP TO PS/2 & LAPTOPS

ONLY $59.00 + $4.00 S/H VISA, MC, COD, UPS-B/R
ORDER TOLL FREE 1-800-523-8777

MICROBRIDGE Computers International, Inc.
655 Sky Way #113, San Carlos, CA 94070
CA 415-593-8777 CN 514-845-0818
DLR INQ FAX 415-593-7675



Have your PC do a 3½!

CIRCLE 382 ON READER SERVICE CARD

You don't need a Memory Hog MENU...

Before there were AT's or even PC/XT's, we needed memory resident MENU's... but with today's fast machines and programs that demand all of your system's memory, you need **Point&Shoot!**

Supports multiple menus, EGA, VGA, mono (CGA not recommended). Screen saver. Continuous on screen clock/calender. Shows space available on HardDisk(s). Displays up to 45 menu entries with English descriptions at a time. Batch file editor.

$49.50 + $5.00 S/H
(California residents add 6.5% tax)

Database Technologies
1547 Palos Verdes Mall, #303
Walnut Creek, CA 94596
(415) 944-5566

VISA MasterCard

CIRCLE 383 ON READER SERVICE CARD

PERSONAL MEASURE

Analyzes performance of live IBM PC applications. Reports CPU, disk, keyboard, printer & comm resources used. *"...developers and end users alike will find... (it) ...a welcome addition..."* - 12/88 Tech Journal. Release 1.1 now measures Netware, NETBIOS, & VINES file activity. Great for DBMSs. $95 (5.25" or 3.5"), $2.50 S&H, MC/VISA, quantity and dealer prices, 30 day MBG.

Spirit of Performance
73 Westcott Road
Harvard, MA 01451
508-456-3889
Telex 6503571400 MCI

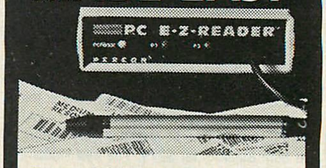
CIRCLE 384 ON READER SERVICE CARD

To Place Your Ad Call 212-503-5115

TECH MARKETPLACE
Standard Directory Listings Available

MISCELLANEOUS/BAR CODING

BAR CODES MADE EASY



PERCON® E-Z-READER™

FAST • ACCURATE • RUGGED

NO SOFTWARE CHANGES with PC/XT/AT and PS/2, AT&T 6300, Wyse 30/60/85/PC/AT, Kimtron KT-7/PC, Link PCTerm/MC1/MC3, TeleVideo PCS1/905/955 & DEC VT220 keyboards, multi-user RS-232 interfaces.

- Immediate shipment
- Free phone support
- 2-year warranty

Details or Questions? Call us.
(503) 344-1189
2190 W. 11th Ave., Eugene, OR 97402

PERCON®

BAR CODE & MAGNETIC STRIPE READERS for the IBM PC & PS/2

Simple & quick installation
No additional software or port
Metal wand & case

Also available:
Bar code printing software
Magnetic stripe encoders
Units for other computers & terminals
GSA pricing available

TPS ELECTRONICS
4047 Transport Street
Palo Alto, CA 94303
Telephone: 415-856-6833
Telex: (Graphnet) 371-9097 TPS PLA
FAX: 415-856-3843

CIRCLE 385 ON READER SERVICE CARD

TECH PC JOURNAL MARKETPLACE

THE COMPREHENSIVE BUYER'S GUIDE FOR SYSTEMS DEVELOPERS AND INTEGRATORS

BAR CODING

Bar Code Headquarters

Bar Code Readers for PC, XT, AT, PS/2, Kimtron, Wyse, Link or any RS-232 terminal. Attaches as 2nd keyboard and inputs data as though keyed. With rugged stainless steel wand—**$399 complete.** Also Laser Readers, Badge Readers, MagStripe Readers, and Portable Readers.

Print Bar Codes on all popular dot matrix printers and HP compatible laser printers. Menu driven or "user callable." All popular bar codes plus several sizes of big text up to 1" tall, readable at 50 feet. Fast, Easy, Well Documented. Several programs from $49 to $279.

Choose from the **industry's largest selection** of PC related hardware and software—direct from the manufacturer/developer. Same day ship. 1 year warranty. 30 day money back guarantee.

WORTHINGTON DATA SOLUTIONS
417-A Ingalls St. (800) 345-4220
Santa Cruz, CA 95060 CA (408) 458-9938
CIRCLE 386 ON READER SERVICE CARD

Bar Code Solutions

ON-LINE BAR CODE READER NETWORK

NEW PC-WAND 300 - up to 128 reader data collection system • Autodiscriminates • Collects, formats and transmits to PC or host.

PC-WAND 800 WanderWand - programmable portable bar code readers.

PC-WAND 200 - terminal wedge on a serial "party line" for mini's.

PC-WAND 100 - emulates 2nd keyboard.

NEW - bar code printing software packages for your printer.

DEALER INQUIRIES INVITED

INTERNATIONAL TECHNOLOGIES & SYSTEMS CORP.
635 North Berry Street, Suite C, Brea, CA 92621
PHONE: 714 990-1880
FAX 714 990-2503
CIRCLE 387 ON READER SERVICE CARD

Multi-Function BAR CODE READERS

$285 Only (Decoder + Wand)

Keyboard emulation/Programable with *Macintosh, Mac Plus, Mac II, SE, IIGS*
IBM PC/XT/AT, PS/2, IBM terminals
Compacq 286, 386; RS-232C
Reads all standard codes
NO software or hardware modifications
Ports for Pen and Laser Scanners

KASCO TECHNOLOGY, INC.
486 Casita Way
Los Altos, CA 94023
(415) 949-0969, FAX (415) 949-3814
Reseller Discounts Available
CIRCLE 388 ON READER SERVICE CARD

DATA CONVERSION

Optical Scanning

Text, graphics, program lists, manuals, etc. converted to micro-computer format. Fast turnaround time. Surprisingly low prices. Phone:

1-800-426-3776
or
1-502-895-6667

TROPUS, Inc.
3704 Hillsboro Rd.
Louisville, KY 40207
CIRCLE 389 ON READER SERVICE CARD

TAPE/DISK CONVERSIONS

Conversion services to or from over 1000 computer systems:

- Magtapes
- Micro Computers
- Mini Computers
- Word Processors
- Typesetters

Our conversion capabilities surpass most in the industry.

PIVAR COMPUTING SERVICES, INC.
165 Arlington Hgts. Rd. #T
Buffalo Grove, IL 60089
(312) 459-6010

SUPPLIES

FREE GLOBAL CATALOG

148 page guide to computer furniture, supplies and accessories

Dial Toll-Free 1-800-8-GLOBAL

GLOBAL COMPUTER SUPPLIES
45 S. Service Rd., Dept. CL
Plainview, NY 11803
CIRCLE 390 ON READER SERVICE CARD

Tech Marketplace
For Info. or to Place Ads Call
800-825-4ADS or
212-503-5115

PROGRAMMERS TOOLS

PC COMPATIBLE ENGINEERING

Annabooks gives you the **hardware, software, and firmware** information you need to design PC-compatible systems faster and better. And you have control of your design from the ground up -- our firmware and software products include **source code!** Plus all the utilities you need.

Do hardware design? **Doctor Design's** 1M DRAM SuperSpec is the first of a series of hardware books you won't want to miss. And a PC Bus timing book is on the way! Start by getting these books:

AT BiosKit: an AT Bios with source code you can modify. With setup & debug. 380 pages with disk, $199
XT BiosKit: Includes a debug. 270 pages with disk, $99
Intel Wildcard Supplement for XT BiosKit: Includes ASIC setup, turbo speeds, 60 pages with disk, $49
1M DRAM SuperSpec: Design your memory to all mfg's specs at once! Lots of timing diagrams & tables, $79
PromKit: Puts anything in Eprom or SRAM; DOS, your code, data, you name it! With source on disk, $179
SysKit: Here's a debug/monitor you can use even with a brand X Bios. Includes source, of course. $69
XT-AT Handbook: The famous pocket-sized book jam-packed with hardware & software info. $9.95 ea. or 5 or more for $5 each.

Software tools: You need MS C & MASM 5.1 for modifying the Kit products.

FREE Mention this ad when you order and get a **free XT-AT Handbook by Choisser & Foster!** Hurry before we come to our senses and change our minds.

Annabooks
12145 Alta Carmel Ct Suite 250-262
San Diego, California 92128 **(619) 271-9526** Money-back guarantee
CIRCLE 391 ON READER SERVICE CARD

Haven't You Heard the News?

You don't have to buy the whole newsstand to get copies of your latest article or review. Order customized reprints from Ziff-Davis Publishing Co. and let potential clients read all about it.*

To find out how you can have your article or review reprinted, contact Jennifer Locke—Reprints Manager; Ziff-Davis Publishing Company, One Park Ave., New York, NY 10016, 212-503-5447.

*Minimum quantity 500 reprints.

MISCELLANEOUS

Comparing ALR 's FlexCache Z Series to Compaq 's Deskpro Computers is like comparing apples to oranges.

When you compare ALR's new small-footprint FlexCache Z-Series to Compaq's Deskpro computers the differences are obvious. For the same price as Compaq's Deskpro 286, you can have ALR's *FlexCache SX386Z*, a 16MHz 80386SX 0-wait state system with 16KB of cache. And for the same price as Compaq's Deskpro 386s, you could have an ALR *FlexCache 20386Z* , a 20MHz 80386 0-wait state system with 64KB of cache. Or for the same price as Compaq's Deskpro 386/20e, you can have the *FlexCache 25386Z* , a 25MHz 80386 0-wait state system with 64KB of cache. Furthermore with every ALR Z-system you get our award winning FlexCache architecture, a powerful 16-bit VGA controller supporting an 800 X 600 graphics mode, Super PC-Kwik™ disk caching utility (*voted PC Magazines Editors Choice*) and an unprecedented three year limited warranty. Plus until May 31,1989 every FlexCache Z- system will ship with Quarterdeck's™ DESQview 386®, multitasking and windowing program. A $189.00 value, absolutely free.

It's a fruitless comparison when ALR is the obvious choice.

ALR FlexCache SX386Z

ALR FlexCache 25386Z

ALR FlexCache 20386Z

Compare for yourself.
Then call our toll free number for your local ALR Reseller. **1-800-444-4ALR**

Price	**$2699.00**	**$2699.00**	**$3799.00**	**$3799.00**	**$5199.00**	**$5199.00**
Models	**ALR® FlexCache SX386**-Mod10	Compaq® Deskpro 286 - Mod10	**ALR® FlexCache 20386Z**-Mod. 10	Compaq® Deskpro 386S-Mod. 10	**ALR® FlexCache 25386Z**-Mod. 10	Compaq® Deskpro 20e- Mod. 10
Microprocessor	80386SX 16MHz 16KB, 82385 Cache	80286 12MHz 1 wait state	80386 20MHz 64KB, EE 82385 Cache	80386sx 16MHz	80386 25MHz 64KB,EE 82385 Cache	80386 20MHz 32KB Cache
Bench Mark*	**3.36 Mips**	**1.93 Mips**	**4.78 Mips**	**2.49 Mips**	**6.07 Mips**	**4.60 Mips**
Opt. Math CoProcessor	80387SX 16MHz	80287 12MHz	80387, Weitek	80387sx	80387, Weitek	80387, Weitek
Memory (RAM)	1MB Expandable to 16MB	640K Expandable to 8MB	1MB Expandable to 14MB	1MB Expandable to 13MB	1MB Expandable to 14MB	1MB Expandable to 16MB
Storage 1.44MB, 3 1/2" FD / 1.2MB, 5 1/4" FD / Fixed Disk Opt..	1 / Optional ($225.00) / 40MB< 28ms	Optional ($275.00) / 1 / 40MB<30ms	1 / Optional ($225.00) / 40MB<35ms, 120MB<28ms	Optional ($275.00) / ! / 20MB<29ms, 40MB<30ms	1 / Optional ($225.00) / 40MB<35ms, 120MB<28ms	Optional ($275.00) / 1 / 40MB<30ms, 110MB<25ms
Video	16 bit VGA 800 X 600		16 bit VGA 800 X 600	VGA 640 X 480	16 bit VGA 800 X 600	VGA 640 X 480

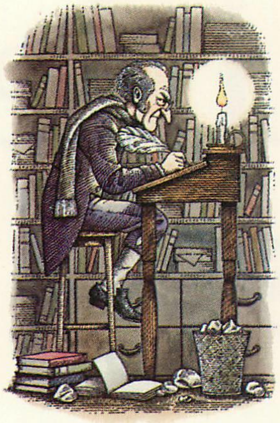
* Data Base Power Meter Ver. 1.5

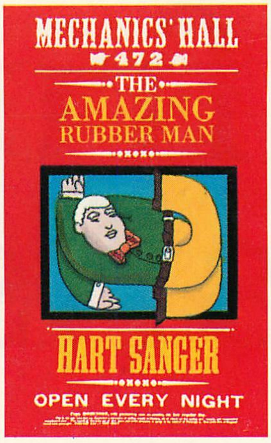
Prices and specifications are subject to change. Verify with manufacturer.

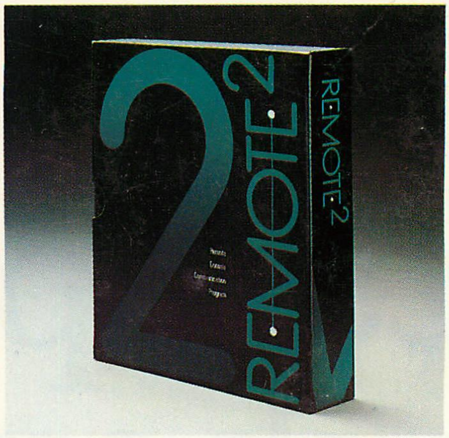
Advanced Logic Research, Inc.
9401 Jeronimo, Irvine, CA 92718
(714) 581-6770 FAX:(714) 581-9240

For our Canadian office: 1-800-443-4CAN
For our UK office: 1-800-444-4ALR
For our Singapore-Asia/Pacific office:
(65) 258-1286 FAX: (65) 258-1285

Circle No. 118 for end-user. No. 116 for reseller.







The Speed of Lightning

Keystrokes. Screen updates. All virtually as fast as the applications program. That's the result of REMOTE^2™ error-checked, data compressed link. It won't keep you waiting.

The Cost-Efficiency of Scrooge

Some programs want you to buy both parts–the calling program and the host program–even if you only need one. Not REMOTE^2. It comes in two parts–R2HOST™ and R2CALL.™ Buy either. Or both. Whatever you need. And no more.

The Flexibility of Rubber Man

R2HOST isn't snobbish. It'll take a call from R2CALL from one of the Crosstalk Communications programs, from almost any other communications program, or from a communications terminal. R2CALL connected with R2HOST does give you all of the power and features of REMOTE^2, including exact keyboard mapping and the ability to transfer files with error-checking even while an applications program is running.

The Heritage of CROSSTALK®

You'd expect a remote control program from the makers of CROSSTALK to be more advanced. We've been leaders in PC communications since the beginning of PC communications.

That's REMOTE^2's family tree. And it shows.

Better, more convenient remote control for almost any application you can think of. Support. Training. Collaboration. Branch office or home computing with a central PC.

REMOTE^2 essentially puts you in front of the remote computer. You have total control of the keyboard, DOS or any applications software. And what you would see on the remote computer's screen, you see on yours. Instantly.

It also provides a wealth of features that make it more efficient and easier to use. A chat window so that you and the person at the distant computer can chat without disturbing the application that's running. An integrated help system that provides help for wherever you are. A phone book of commonly used numbers–along with their communications settings. LAN and mainframe access. And an activity log.

If you need to operate a distant computer by remote control, look at this one–REMOTE^2. From the makers of CROSSTALK. See your dealer or contact us for details.

REMOTE^2

INFO WORLD
BEST IN ITS CLASS

CROSSTALK COMMUNICATIONS
1000 Holcomb Woods Parkway
Roswell, Georgia 30076-2575
404/998-3998

A Division of Digital Communications Associates, Inc. dca

CIRCLE NO. 159 ON READER SERVICE CARD